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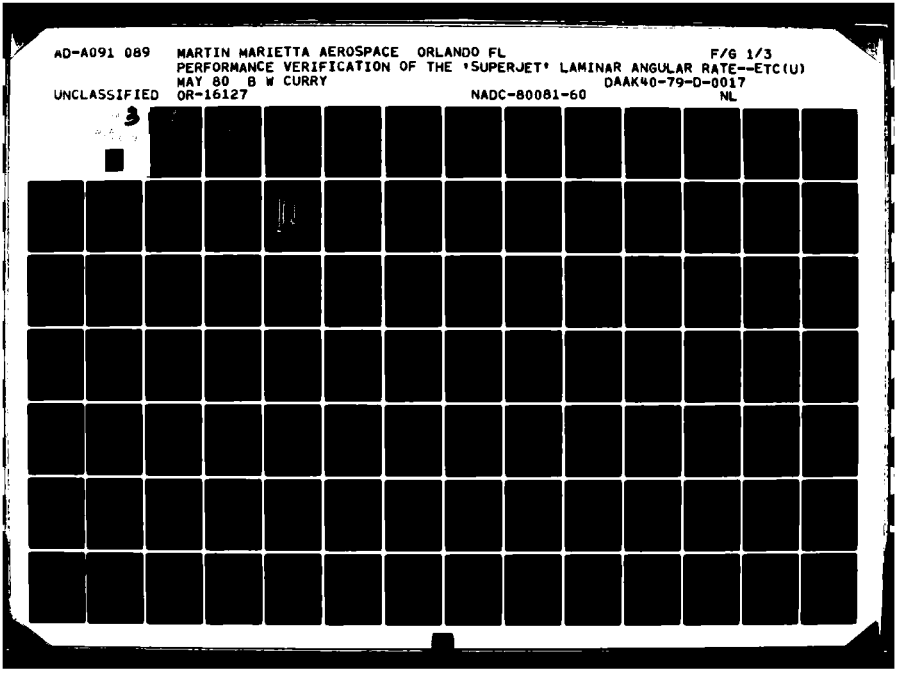
PERFORMANCE VERIFICATION OF THE 'SUPERJET' LAMINAR ANGULAR RATE--ETC(U)
MAY 80 B W CURRY DAAK40-79-D-0017
UNCLASSIFIED OR-16127 NADC-80081-60 NL



TECHNICAL REPORT
NADC 80081-60

LEVEL II

12 P.S.

PERFORMANCE VERIFICATION OF THE "SUPERJET" LAMINAR ANGULAR RATE SENSOR

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May 1980

FINAL REPORT

Approved for Public Release:
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NAVAL AIR DEVELOPMENT CENTER (6013)
AIRCRAFT AND CREW SYSTEMS TECHNOLOGY DIRECTORATE
WARMINISTER, PENNSYLVANIA 18974

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(19) **REPORT DOCUMENTATION PAGE**

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(18) 1. REPORT NUMBER: NADC-80081-60	2. GOVT ACCESSION NO.: AD-A091089
3. RECIPIENT'S CATALOG NUMBER	
(6) 4. TITLE (and Subtitle): PERFORMANCE VERIFICATION OF THE "SUPERJET" LAMINAR ANGULAR RATE SENSOR.	(9) 5. TYPE OF REPORT & PERIOD COVERED: FINAL rept. 5 NOV 79 — 5 MAY 80
	(14) 6. PERFORMING ORG. REPORT NUMBER: OR-16 127
(10) 7. AUTHOR(s): BOYD W. CURRY, JR.	(15) 8. CONTRACT OR GRANT NUMBER(s): ~~CONTRACT~~ DAAK40-79-D-0017 D.O. 0006
9. PERFORMING ORGANIZATION NAME AND ADDRESS: MARTIN MARIETTA ~~CORPORATION~~ POST OFFICE BOX 5837 ORLANDO, FLORIDA 32855	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62241N F41 400 000 (17)
11. CONTROLLING OFFICE NAME AND ADDRESS: AIRCRAFT AND CREW SYSTEMS TECHNOLOGY DIRECTORATE (6013) NAVAL AIR DEVELOPMENT CENTER WARMINISTER, PENNSYLVANIA 18974	(11) 12. REPORT DATE: MAY 80 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (12) 205	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SUPERJET RATE SENSOR ENVIRONMENTAL TESTING

ESCAPE SYSTEM EJECTION SEAT

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covers work accomplished under contract DAAK40-79-D-0017-0006, "Performance Verification of the Superjet Angular Rate Sensor" for potential application on the Maximum Performance Escape System (MPES) Program. Three Hamilton Standard Superjet Angular Rate Sensors (9304100-099) were subjected to a test program.

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The performance data collected from this test can be summarized as follows:

PERFORMANCE

Full Scale Rate At ±2% Linearity	500 ±100 deg/sec
Scale Factor	.0062 ±.0002 deg/sec
Null Bias (calculated)	±2 deg/sec
Hysteresis	±0.6 deg/sec
Threshold	<0.1 deg/sec
Resolution	<0.1 deg/sec
Readytime	80 milliseconds maximum
Drift	+0.76 deg/sec/min
Null Offset (measured)	±2 deg/sec
G-Sensitivity	1.68 deg/sec/g/maximum
High Temperature Tested	+165°F
Low Temperature Tested	-30°F
Sensitivity to Jerk	Negligible
Acoustic Sensitivity	Negligible
Vibration Sensitivity	±2 deg/sec at approx. 2,000 Hz

Additional information obtained regarding the three units tested as as follows:

Null Bias Drift @ 72°F	.166 deg/sec over 15 minute period
Reliability	
Storage Failure	<.9906
Operating Failure	<.9999995
Weight	12.0 ounces
Volume	1.5 x 3.5 x 5.0

It is recommended that additional investigation of the g-sensitivity effects be performed when the requirements of the MPES program are defined.

EXECUTIVE SUMMARY

This report covers work accomplished under contract DAAK40-79-D-0017-006, "Performance Verification of the Superjet Angular Rate Sensor," for potential application on the Maximum Performance Escape System (MPES) Program. Three Hamilton Standard Superjet Angular Rate Sensors (9304100-099) were subjected to a test program.

The performance data collected from this test can be summarized as follows:

PERFORMANCE

Full Scale Rate At ±2% Linearity	500 ±100 deg/sec
Scale Factor	.0062 ±.0002 deg/sec
Null Bias (calculated)	±2 deg/sec
Hysteresis	±0.6 deg/sec
Threshold	<0.1 deg/sec
Resolution	<0.1 deg/sec
Readytime	80 milliseconds maximum
Drift	+0.76 deg/sec/min
Null Offset (measured)	±2 deg/sec
G-Sensitivity	1.68 deg/sec/g/maximum
High Temperature Tested	+165°F
Low Temperature Tested	-30°F
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It is recommended that additional investigation of the g-sensitivity effects be performed when the requirements of the MPES program are defined.

CONTENTS

ILLUSTRATIONS

TABLES

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1.0 INTRODUCTION

The need exists for small rugged rate sensors applicable to the Navy's Maximum Performance Escape System. A recent study indicated that a prime candidate for this system is the Superjet rate sensor used on the U.S. Army Copperhead Program.

The Superjet performance verification contract DAAK 40-79-D-0017/006 was initiated on September 1979 by the U.S. Army Missile Command, Redstone Arsenal, Alabama. The program is under the technical direction of the Naval Air Development Center (NADC), Aircraft and Crew Systems Technology Directorate, Warminister, PA. Mr. R. L. McGiboney is the cognizant Project Engineer for this program.

The purpose of this performance verification task is to determine through test and analyses the suitability of the Hamilton-Standard Superjet angular rate sensor for the possible application in NADC's Maximum Performance Escape System (MPES) program.

For NADC to make that determination, a test plan (Appendix B) was submitted and approved. The results of the tests are presented in this report.

In addition, technical tasks described in the statement of work 60134-12, Paragraph 3.2, are discussed in the text. These tasks include operational mode, (4 second or 15 minute performance duration), reliability, maintainability, weight and volume.

---

1 Reference: Fluidic Gyro Development, Martin Marietta OR15,646 prepared under contract N00019-78-C-0298. Prepared for:

Department of the Navy
Naval Air Systems Command
Advanced Technology Section
AIR-5162C
Washington, DC 20360

2.0 DESIGN AND ANALYSIS

2.1 Design

2.1.1 Description

The Superjet rate sensor is manufactured by Hamilton Standard, Farmington, Connecticut, Part Number 9304100-099. The package includes a pump which directs a stream of helium between two resistive elements. The change in cooling of these elements by the gas stream is sensed to indicate angular rate. The package also includes the required electronics (analog type); so all that is required is a ±15 V.D.C. power supply and a voltmeter. Output of the device is ±6 V.D.C.

The three Superjet rate sensors used during this evaluation were serial numbers 0100355, 0100373, and 0100381, which will be referred to as serial numbers 355, 373, and 381, respectively. A drawing describing the Superjet package is shown in Figure B.2-1, Appendix A, Part B of this report.

A cross section of the Superjet sensor is shown in Figure 2.1-1.

The Copperhead program roll rate sensor specification may be found in Martin Marietta document SPC10200000-004.

The vendor specifications for Superjet are listed in Table 2.1-I.

2.1.2 Concept

The principle of operation of the Superjet may be most readily visualized by referring to Figure 2.1-2. As illustrated in this figure, a laminar flow gas jet flows with an average velocity V_j, from a nozzle located at one end of the case. A jet position sensor, located a distance, L, from the nozzle mouth is used to detect any lateral deflection, y, of the gas jet from the center position. In the presence of an angular rate ω_I, along the input axis of the case, the jet will be deflected away from its normal center position in proportion to the magnitude of the rate, and in a direction corresponding to the clockwise or counterclockwise direction of the angular rate. The amount of this deflection may be calculated by double integration of the Coriolis acceleration of the jet as it flows toward the jet position sensor:

$$\ddot{y} = 2\omega_I V_j \qquad \text{Eq (1)}$$

$$\dot{y} = 2\omega_I V_j T \qquad \text{Eq (2)}$$

$$y = \omega_I V_j T^2 \qquad \text{Eq (3)}$$

At the position sensor:

$$y = \omega_I V_j T^2 = \omega_I LT = \omega_I \frac{L^2}{V_j} \qquad \text{Eq (4)}$$

where $L = V_j T$

Thus, it can be seen from the above equation that the gas jet deflects in proportion to the input angular rate perpendicular to the axis of the jet. Moreover, the deflection is proportional to the product of the length of the jet, L, and the transit time of the jet, T, or to the length squared divided by the jet velocity. The above computation is based on small angle approximations which can be shown to be valid for actual Superjet design parameters.

Constant translational velocities of the sensor in any direction do not cause jet deflections relative to the jet position sensor. Translational acceleration is claimed also not to introduce any first order error since the laminar gas flow jet is essentially buoyantly supported within the free gas space. Acceleration does produce density gradients, however, which may cause second order errors. These, however, are claimed to be an order of magnitude smaller than comparable errors for equivalent mechanical gyros.

In order to maintain gas jet stability and produce a low noise signal, the jet must be kept within the laminar flow regime. This is achieved by limiting the the Reynolds number to a value below 1,000. Laminar flow is most readily produced with a gas having a low density and high viscosity since Reynolds number is proportional to density and inversely proportional to the viscosity of the gas. Also, from the standpoint of obtaining maximum frequency response, it is desirable to have the gas jet velocity as high as possible consistent with laminar flow criteria. Conversely, it should be recalled from the previous equations that lateral deflection is inversely proportional to the velocity. Thus, the selected design velocity represents a compromise between frequncy response and sensitivity.

Conversion of the jet deflection into an electrical signal proportional to the input rate is accomplished by symmetrically mounting two temperature sensitive resistors on either side of the jet stream and connecting them by means of a bridge circuit. As the jet deflects to the left or right, the differential cooling of the temperature sensitive resistors produces an output voltage that varies linearly with input rate, over a limited range of angular rate input.

2.2 Operational Mode

The accuracy of the roll rate sensors does not change under any of the two MPES scenarios considered.

2.2.1 Four Second Scenario

The Superjet rate sensor is best suited for this scenario. There is virtually no shift in the null bias for this short time frame. It is known, however, that the electronics of the Superjet package is not temperature compensated beyond a range of -25° to +145°F.

2.2.2 Fifteen Minute Scenario

The null bias at 72°F $\pm$5°F has a shift of about 1 mv over a 15 minute period which is equivalent to .166 degrees per second rate, which was indicated by observing the units throughout the test program. Drift test data are reported for one mintue periods, in Sections 3.1, 3.3, 3.4, 3.6 and 3.7.

2.3 Reliability

The only moving mechanical part in the Superjet Angular Rate Sensor is the vibrating pump diaphragm. This diaphragm consists of a ceramic piezoelectric crystal which is flexibly mounted around its periphery and has electrically excited faces perpendicular to the mounting plane. Stress levels induced under normal operating amplitude conditions are approximately 17 percent of rated fatigue strength. As a result, the crystal may vibrate indefinitely without limiting the life of the sensor.

Life tests on five experimental models have exceeded 34,000 hours each or a cumulative total of over 170,000 hours without failure. The complete absence of wear limited components in both the jet sensor and the electronics has made it possbile to attain a virtually unlimited unit life.

The environmental resistance of the sensor assembly has been analysed for a broad spectrum of vibration, shock and acceleration dynamic conditions.

The Superjet Angular Rate Sensor is exceptionally tolerant to angular rate overranging. This is a consequence of the fact that overranging does not produce an internal mechanical force on stops, gimbal suspensions, or spin bearings as in conventional rate gyroscopes. Thus, the unit will recover from any degree of overranging without degradation of performance.

Electronic oscillator driver and bridge output amplifier circuits are extremely simple. Failure rates for these components were derived from MIL-HDBK-217A, using 71°C ambient temperature and environmental stress factors for manned aircraft. The predicted failure rate of the complete circuitry totals four failures per million hours, or an equivalent MTBF of 250,000 hours. This gives an operating probability of success 0.999996.

The "Superjet" roll rate sensor is currently used on the "Copperhead" program which is a cannon launched guided projectile. Early reliability predictions on Copperhead, for the roll rate sensor, produce the following probability of success:

Storage Failure	<.9906
Operating Failure	<.9999995

This was based on the reliability math model as shown in Figure 2.3-1, (Reference: Copperhead (CLGP) Reliability (RAM-D) Report, Eleventh Bimonthly, CK1 SRP 00801000-011, Figure 1, Page 151).

2.4 Maintainability

The Superjet rate sensor is a hermetically sealed unit fabricated by Hamilton Standard. There are no outside moving parts and there is no maintenance requirement. If there is a malfunction, on the Copperhead program, the sensor is replaced, and sent back to the manufacturer for refurbishment.

2.5 Weight and Volume

The total weight of the Superjet package is 12.0 ounces and the total volume does not exceed 1.5" x 3.5" x 5". Figure 2.5-1 shows the outline of the sensor package.

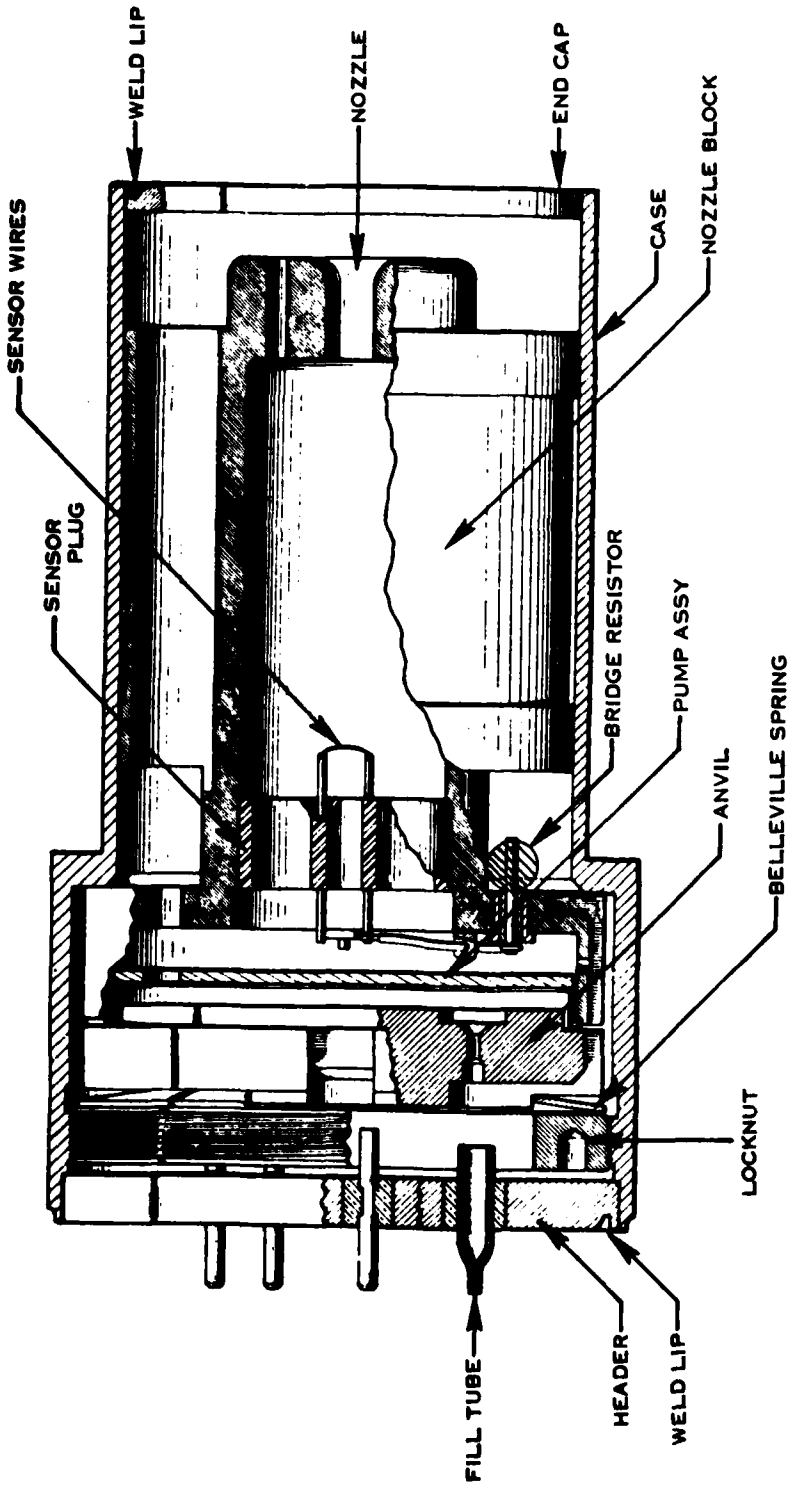
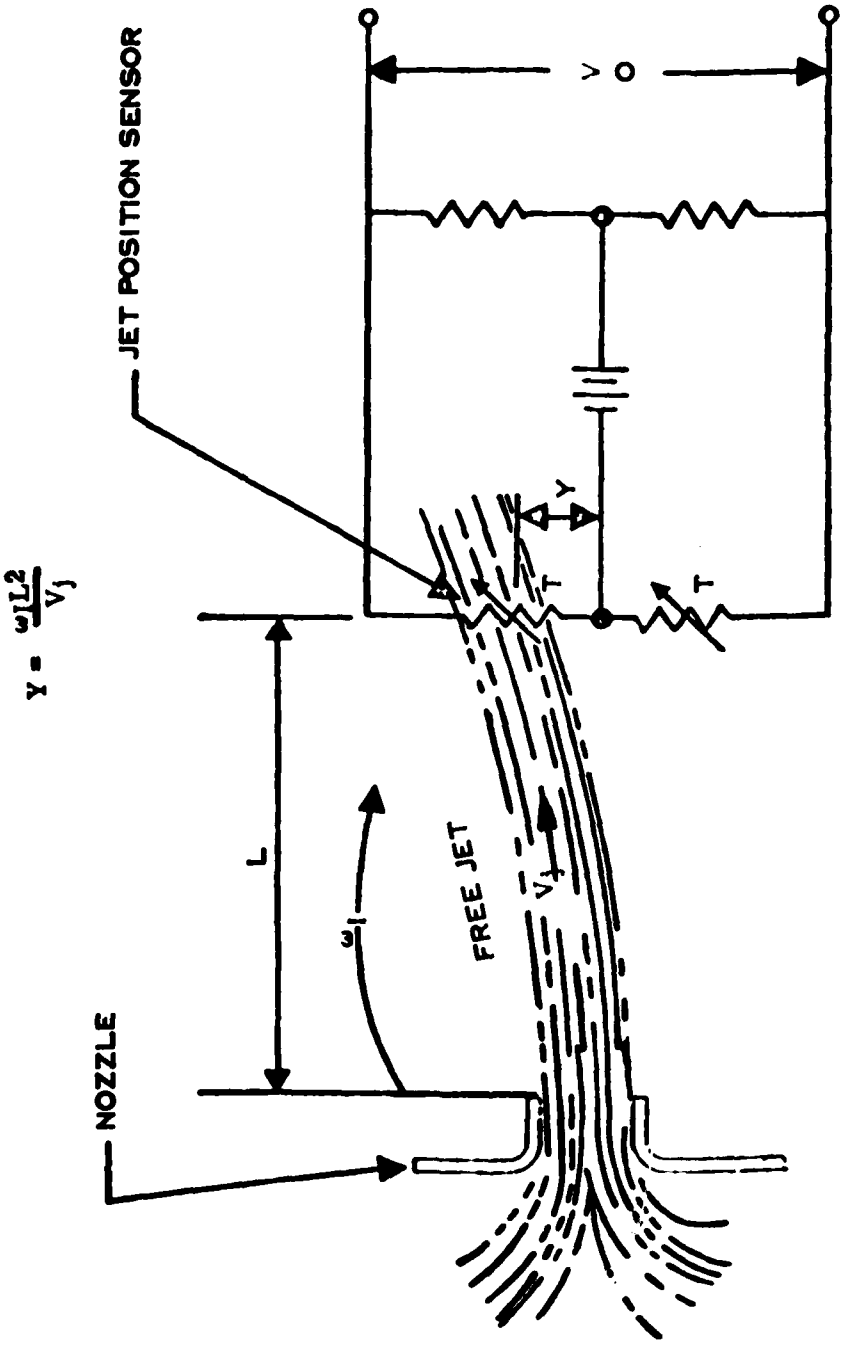


FIGURE 2.1-1

SUPERJET SENSOR CROSS SECTION



$$Y = \frac{\omega L^2}{V_j}$$

FIGURE 2.1-2 SUPERJET ANGULAR RATE SENSOR SCHEMATIC

SUPERJET RATE SENSOR SPECIFICATION

HAMILTON STANDARD

Weight of jet:	3.8 oz
Weight of total package:	12.0 oz
Input voltage:	+15V at 80 mA -15V at 7 mA
Rate range:	500 deg/s
Scale factor:	Rate - 6 mV/deg/s Angle - 120 mV/deg
	Null stability - $\pm$0.6 deg/s (when bias is stored during rates) (absolute, environment)
	Scale factor - 15% (absolute, linearity, environment, and symmetry)
Linear acceleration sensitivity:	0.02 deg/s/g
Frequency response:	>40 Hz
Input axis alignment:	<½ degree
Environmental capacity:	Temperature: -25°F to +155°F Vibration: 7.6g rms Shock: 10,000g

TABLE 2.1-I

1.0 Factory Acceptance Test	2.0 Storage	3.0 Deploy-ment	4.0 Loading and Waiting	5.0 Non Oper Flight	6.0 Operating Flight	7.0 Detonation

$$P_R = R^*_{1.0} \times R_S \times e^{-\left[(\lambda_{NO})(t_1)(K_S) + (\lambda_{NO})(t_2)(K_D) + (\lambda_{NO})(t_3)(K_L) + (\lambda_{NO})(t_4)(K_W) + (\lambda_{NO})(t_5)(K_F) + (\lambda_{OP})(t_6)\right]}$$

P_R Expected or Predicted Reliability of One Roll Rate Sensor.

$R^*_{1.0}$ = 0.99999 based on the Roll Rate Sensor being capable of 100% acceptance testing of all functional requirements. The Roll Rate Sensor contains no one shots.

e Base for Natural or Napierian Logarithms = 2.71828.

λ_{NO} Non-operating or Storage Failure Rate (Time Dependent Elements) = 1.0691×10^{-7} (see Table I).

t_1 Storage Duration = 87,600 hours (10 years covered storage) maximum.

K_S Storage Environmental Factor = 1.0.

t_2 Deployment Duration (t_2 = 36 hours).

K_D Deployment Environment Factor = 5.0.

t_3 Loading Duration = 0.0055 hours.

K_L Loading Environmental Factor = 5.0.

t_4 Waiting Duration = 0.0167 hours.

K_W Waiting Environmental Factor = 1.0.

t_5 Flight Duration Non-operating = 0.0047 hours (midrange flight).

K_F Firing Environmental Factor = 1000.0.

λ_{OP} Operating Failure Rate Including K Factors (Time Dependent Elements) = 3.90566×10^{-5} (see Table II).

t_6 Flight Duration Operating = 0.0119 hours (midrange flight).

R_S Reliability of Structure and Pump Diaphragm = .99999.

FIGURE 2.3-1

COPPERHEAD RELIABILITY MATH MODEL

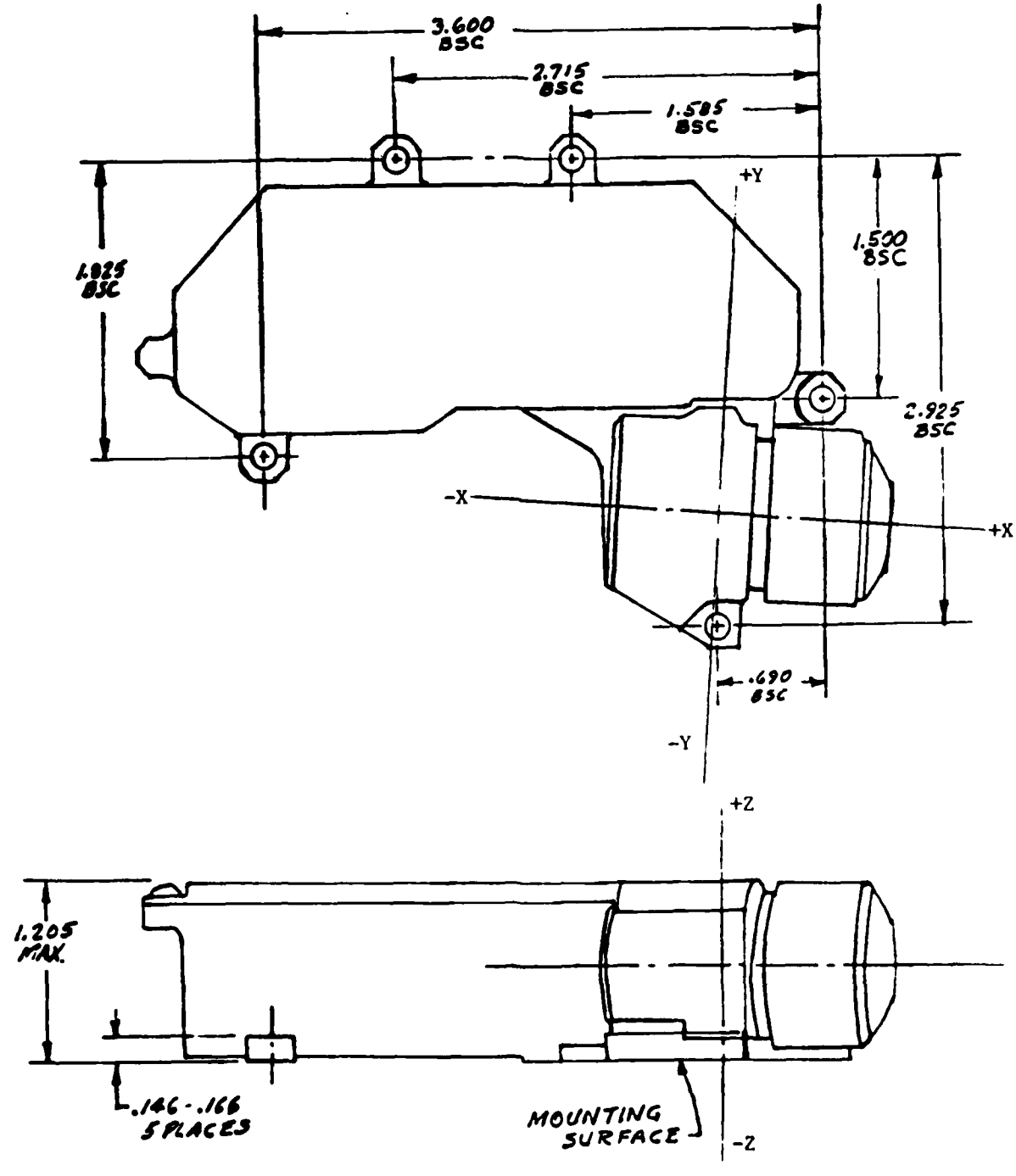


FIGURE 2.5-1

SUPERJET RATE SENSOR

3.0 PERFORMANCE TESTS

Three Superjet roll rate sensors were subjected to a series of baseline tests consisting of the following:

input voltage (volts)
input current (amps)
full scale range at 2% linearity (degrees/seconds)
hysteresis (millivolts)
threshold (degrees/seconds)
resolution (degrees/seconds)
output drift (degrees/seconds)
ready time (seconds)
null offset (add after initial baseline testing) (millivolts)

The sensors were then monitored for various environmental factors which included the following:

Sensitivity to acceleration (degrees/second/G)
Temperature sensitivity at +165°F
Temperature sensitivity at -30°F
Sensitivity to jerk (å)
Acoustic sensitivity
Vibration environment

A majority of the performance testing was conducted in Martin Marietta's Precision Inertial Laboratory. The acoustic and vibration environments were generated in the Environmental Test Lab of the Orlando Division. Barometric pressure was 30.00 $\pm$ .08 in Hg throughout the test program.

A Hewlett Packard 9500 test set was used in the Inertial Lab, to program the Genisco 1100-2 rate table. The rate table was wired to the computer such that all power input to the Superjet test unit occurred simultaneously. This allowed the Superjet sensor to experience the actual procedure involved during a real ejection situation.

3.1 Baseline Tests

3.1.1 Test Setup and Procedure

Three "Superjet" rate sensor packages were tested in the Precision Inertial Laboratory on the Genisco series 1100-2 rate table. This rate table is programmable by paper tape reader or automatic test set for automatic operation. Speed accuracy is 0.01%; the table servo has a peak torque of 22 ft.-lbs.

The Hewlett Packard 9500A-145 test set was used to program the rate table. The test set includes a Hewlett Packard HP2116C computer controlling two 50-volt and two 100-VDC programmable power supplies as well as five non-programmable 20-ampere, 40 VDC power supplies controlling a programmable counter, oscilloscope, a volt-ohm meter and a modular switch for control of these devices.

Each test unit was centrally located on the rate table by using a standard 8"x8"x8" test cube in the lab. The input axis of the sensor coincided with the rotation axis of the rate table.

The computer in the test set was programmed to increment the rate table (usually in 50 degree/second increments) to the maximum counterclockwise rate and back through zero to the maximum clockwise rate and back to zero rate. The actual rate and output of the sensor was recorded at each rate increment. Each data point represented an average of 40 readings taken within approximately 1.6 seconds or less. The maximum rate was varied by 50 degrees/second intervals until the non-linearity exceeded $\pm$2% of full scale, as calculated using a least-squares-fit straight line.

The output drift of each unit was measured on the rate table with the computer programmed to give a readytime plot, wait 15 seconds and take an average of 40 readings of the output, and repeat for a one minute time period, at 15 second intervals. This was done for rates of 100, 200, 300, 400 and 500 degrees/second.

Threshold and resolution was derived by rotating the rate table from 0.0 degrees/second to 1.0 degrees/second in 0.1 degree/second increments. And 5.0 degrees/second to 6.0 degrees/second in 0.1 degree/second increments, respectively.

A test schematic for the baseline test is shown in Appendix A, Figure A.2-1 of this report.

The test program was conducted under the guidance of the Test Plan (see Appendix B) prepared by Jerome C. Salmons, November 1979 which was approved by NADC on January 11, 1980. A detailed procedure for the baseline tests is shown in Appendix A, Part A of this report.

The algorithm used for calculating the least-squares-fit data and output drift may be found in Appendix C.

3.1.2 Baseline Test Results

The scale factor was computed as the slope of the least-squares-fit straight line. Percentage error from both fullscale and "ideal" (actual reading) was calculated for each data point.

The full scale rate of the sensor was determined by the $\pm$2% linearity error requirement. Hysteresis values for clockwise and counterclockwise rates were calculated. The bias shown on the data sheets was determined as the Y-intercept of the least-squares-fit straight line.

A typical plot of voltage output vs. rate is shown in Figure 3.1.2-1 for S/N 355. Since the hysteresis error is so small (.002% of full scale) the plot is a straight line. This figure was transposed from Table 3.1.2-I. The scale factor program printouts are shown for all three serial numbers in Tables 3.1.2-I through 3.1.2-VI.

The first column in this table is the actual rate of the rate table as recorded by the computer with an accuracy within .01%. The second column is the average of 40 readings taken while dwelling at a known rate. The third column is the calculated value of the output using the curve fitting technique of the least squares fit straight line. The fourth column is the error of the particular data point as percentage of the full scale rate (from the least squares fit straight line). The fifth column is the error of each data point as a percentage of the corresponding output from the least squares fit straight line. A test summary is provided at the bottom of each table for individual evaluation.

Tables 3.1.2-VII through 3.1.2-IX show the results of the output drift. The first reading for each rate input is the output value after 15 seconds. The next reading is the value after 30 seconds. The third and fourth readings are the values for 45 and 60 seconds respectively. The third column is the mean divided by the actual rate. This was used to evaluate the drift since there were small changes in rates.

A typical readytime plot is shown in Figure 3.1.2-2. Readytime is defined as the time required for the device to reach 95% of its steadystate output without any electronic warmup, at any rate.

Threshold and resolution for the "Superjet" rate sensor was found to be less than 0.1 degrees/second. The actual value was not obtained due to the limited accuracy of the equipment used. It is believed that for the maximum performance escape system, a threshold and resolution of 0.1 degree second for this device will not impair the expected system performance significantly. The specification made by the Copperhead program at Martin Marietta called for Superjet threshold and resolution to be 0.03 degree/second maximum.

3.1.3 Data Evaluation

Baseline test data for the three Superjet rate sensor packages tested produces the following worst case evaluation:

1.	Full scale rate at $\pm$2% linearity	475 $\pm$75 degrees/second
2.	Scale Factor	.0061 $\pm$.0001 V/degrees/second
3.	Bias	$\pm$.26 degrees/second
4.	Hysteresis	$\pm$.56 degrees/second
5.	Threshold	<.1 degrees/second
6.	Resolution	<.1 degrees/second
7.	Readytime	.068 second maximum
8.	Drift	+.55 degrees/second/minute max.

The values for each unit may be evaluated from Table 3.1.3-I (baseline test data) and Table 3.1.3-II (baseline drift and readytime test data).

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE.....2-18-80..... RUN.....Initial Baseline.....

TEMP...72°F....50%RH. SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.989	.2953	.3057	.342	-3.418
	-99.8422	.5898	.609	.628	-3.147
	-149.639	.8873	.9119	.81	-2.706
*	-199.549	1.1873	1.2155	.929	-2.328
	-249.455	1.4913	1.5191	.915	-1.834
	-299.286	1.7996	1.8223	.746	-1.246
	-349.236	2.1134	2.1261	.418	-.598
	-399.008	2.4332	2.4289	-.143	.179
	-448.893	2.7598	2.7324	-.901	1.003
	-498.808	3.093	3.036	-1.872	1.876
	-448.988	2.7613	2.733	-.93	1.036
	-399.032	2.4354	2.4291	-.21	.263
	-349.182	2.1163	2.1258	.312	-.447
	-299.329	1.8029	1.8225	.645	-1.077
	-249.395	1.4945	1.5188	.796	-1.596
	-199.499	1.1906	1.2152	.808	-2.025
	-149.69	.8906	.9122	.711	-2.375
	-99.7762	.5929	.6086	.513	-2.573
	-49.9797	.2975	.3056	.268	-2.683
	49.8369	-.2926	-.3016	-.297	-2.933
*	99.7095	-.5881	-.605	-.557	-2.792
	149.589	-.8862	-.9084	-.731	-2.445
	199.43	-1.1863	-1.2116	-.834	-2.092
	249.322	-1.4899	-1.5152	-.83	-1.664
	299.192	-1.7976	-1.8185	-.687	-1.147
	349.056	-2.11	-2.1219	-.392	-.562
	398.962	-2.4282	-2.4255	.091	.114
	448.814	-2.7528	-2.7287	.791	.882
	498.677	-3.0835	-3.0321	1.691	1.696
	448.862	-2.7533	-2.729	.799	.89
	398.921	-2.4291	-2.4252	.126	.158
	349.087	-2.1114	-2.1221	-.35	-.501
	299.178	-1.7988	-1.8184	-.645	-1.078
	249.374	-1.4914	-1.5155	-.792	-1.587
	199.459	-1.188	-1.2118	-.784	-1.966
	149.545	-.888	-.9082	-.663	-2.216
	99.7078	-.5903	-.605	-.483	-2.421
	49.8523	-.2944	-.3017	-.24	-2.409

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.08342E-03

BIAS (VOLTS) : 1.57557E-03

HYSTERESIS, NEG RATES (VDC): -3.37982E-03

HYSTERESIS, POS RATES (VDC): 2.23863E-03

TEST ENGINEER.....

2-18-80

READY

TABLE 3.1.2-1

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE...2-18-80..... RUN Initial Baseline

TEMP..72°F...50%RH.. SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9388	.2951	.3073	.362	-3.984
	-99.8574	.5896	.6124	.68	-3.748
	-149.648	.8863	.9168	.908	-3.339
*	-199.549	1.1858	1.2219	1.072	-2.953
	-249.487	1.4898	1.5271	1.11	-2.447
	-299.272	1.7978	1.8315	1.001	-1.84
	-349.167	2.1117	2.1365	.738	-1.162
	-399.037	2.4313	2.4413	.299	-.412
	-448.851	2.7573	2.7459	-.34	.416
	-498.805	3.0903	3.0512	-1.161	1.28
	-548.737	3.42993	3.35652	-2.183	2.188
	-498.766	3.0918	3.051	-1.213	1.338
	-448.95	2.7598	2.7465	-.398	.488
	-399.057	2.4343	2.4415	.212	-.292
	-349.147	2.115	2.1364	.635	-1
	-299.296	1.8017	1.8316	.889	-1.634
	-249.444	1.4938	1.5269	.984	-2.171
	-199.492	1.19	1.2215	.938	-2.587
	-149.678	.8899	.917	.804	-2.956
	-99.8151	.5927	.6122	.581	-3.199
	-49.9625	.2971	.3074	.305	-3.362
	49.8529	-.2924	-.3028	-.309	-3.41
	99.7061	-.5876	-.6075	-.591	-3.26
	149.584	-.885	-.9124	-.815	-2.998
	199.444	-1.1847	-1.2172	-.968	-2.669
	249.349	-1.4881	-1.5223	-1.018	-2.245
*	299.215	-1.7952	-1.8271	-.949	-1.745
	349.153	-2.1076	-2.1324	-.738	-1.162
	398.94	-2.4257	-2.4368	-.328	-.452
	448.792	-2.7502	-2.7415	.259	.318
	498.706	-3.0811	-3.0466	1.026	1.131
	548.615	-3.41805	-3.35169	1.974	1.979
	498.693	-3.0821	-3.0466	1.058	1.167
	448.853	-2.7519	-2.7419	.298	.365
	398.968	-2.4279	-2.4369	-.268	-.37
	349.126	-2.1103	-2.1322	-.652	-1.027
	299.217	-1.7979	-1.8271	-.869	-1.596
	249.349	-1.4906	-1.5223	-.942	-2.079
	199.481	-1.1872	-1.2175	-.899	-2.478
	149.578	-.8876	-.9124	-.739	-2.716
	99.6536	-.5902	-.6072	-.504	-2.784
	49.8472	-.2943	-.3027	-.251	-2.766

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550
SCALE FACTOR (V/DEG/SEC): -6.11309E-03
BIAS (VOLTS) : 1.98895E-03
HYSTERESIS, NEG RATES (VDC): -4.12464E-03
HYSTERESIS, POS RATES (VDC): 2.72226E-03

TABLE 3.1.2-II TEST ENGINEER...[signature]
2 18 80

READY

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE...2-18-80..... RUN.Inital Baseline

TEMP...72°F..50%RH.. SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9477	.2945	.3058	.461	-3.69
	-99.766	.5947	.6122	.712	-2.853
*	-149.737	.8985	.9196	.856	-2.288
	-199.612	1.2061	1.2263	.823	-1.65
	-249.448	1.519	1.5328	.563	-.904
	-299.355	1.8379	1.8398	.078	-.105
	-349.235	2.1641	2.1466	-.711	.815
	-399.093	2.4978	2.4532	-1.814	1.818
	-349.206	2.1648	2.1464	-.748	.857
	-299.35	1.8391	1.8398	.027	-.036
	-249.453	1.5206	1.5329	.501	-.803
	-199.555	1.2079	1.226	.734	-1.471
	-149.71	.9006	.9194	.765	-2.044
	-99.8404	.5966	.6127	.656	-2.63
	-49.9325	.2957	.3058	.41	-3.28
	49.8582	-.3034	-.308	-.187	-1.5
	99.7501	-.6034	-.6149	-.467	-1.873
*	149.591	-.9055	-.9214	-.645	-1.725
	199.483	-1.2111	-1.2282	-.696	-1.395
	249.359	-1.521	-1.535	-.568	-.912
	299.221	-1.8359	-1.8417	-.233	-.312
	349.141	-2.1575	-2.1487	.359	.411
	399.028	-2.4857	-2.4555	1.226	1.229
	349.109	-2.1581	-2.1485	.39	.446
	299.222	-1.8371	-1.8417	-.188	-.251
	249.374	-1.5221	-1.5351	-.53	-.85
	199.539	-1.2126	-1.2286	-.652	-1.307
	149.561	-.9074	-.9212	-.563	-1.505
	99.7179	-.6047	-.6147	-.406	-1.628
	49.8778	-.3043	-.3081	-.154	-1.234

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 400

SCALE FACTOR (V/DEG/SEC): -6.15037E-03

BIAS (VOLTS) : -1.35492E-03

HYSTERESIS, NEG RATES (VDC): -2.08056E-03

HYSTERESIS, POS RATES (VDC): 1.84214E-03

TEST ENGINEER [signature] 2·18·80

READY

TABLE 3.1.2-III

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..2-18-80..... RUN..Inital Baseline

TEMP..72°F....50%RH.. SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9608	.2946	.3096	.538	-4.849
*	-99.8506	.5953	.6187	.837	-3.771
	-149.648	.8998	.9272	.98	-2.948
	-199.546	1.2078	1.2363	1.022	-2.305
	-249.431	1.5213	1.5453	.861	-1.554
	-299.318	1.8406	1.8543	.492	-.74
	-349.196	2.1668	2.1633	-.124	.16
	-399.035	2.5006	2.4721	-1.024	1.154
	-448.954	2.8432	2.7813	-2.22	2.225
	-399.108	2.5015	2.4725	-1.041	1.173
	-349.235	2.1677	2.1635	-.15	.193
	-299.368	1.8417	1.8546	.464	-.697
	-249.512	1.5225	1.5458	.834	-1.504
	-199.587	1.2095	1.2365	.969	-2.186
	-149.759	.9017	.9278	.939	-2.822
	-99.8219	.5975	.6185	.754	-3.398
	-49.9438	.2961	.3095	.482	-4.339
	49.8885	-.3035	-.3089	-.194	-1.746
	99.7585	-.6037	-.6179	-.509	-2.295
	149.572	-.9061	-.9265	-.728	-2.191
*	199.422	-1.2117	-1.2353	-.845	-1.907
	249.369	-1.5219	-1.5447	-.817	-1.474
	299.209	-1.8371	-1.8534	-.585	-.88
	349.117	-2.1588	-2.1626	-.135	-.174
	398.963	-2.4875	-2.4714	.577	.651
	448.943	-2.8236	-2.781	1.529	1.532
	399.009	-2.488	-2.4717	.587	.662
	349.112	-2.16	-2.1626	-.092	-.118
	299.219	-1.8384	-1.8535	-.542	-.815
	249.379	-1.5232	-1.5447	-.773	-1.395
	199.412	-1.2134	-1.2352	-.783	-1.768
	149.654	-.9078	-.927	-.688	-2.07
	99.7332	-.6049	-.6177	-.458	-2.066
	49.8699	-.3044	-.3088	-.158	-1.423

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450
SCALE FACTOR (V/DEG/SEC): -6.19478E-03
BIAS (VOLTS) : 1.14196E-04
HYSTERESIS, NEG RATES (VDC): -2.13492E-03
HYSTERESIS, POS RATES (VDC): 1.65558E-03

TEST ENGINEER [signature]
2-18-80

READY

TABLE 3.1.2-IV

RATE SENSOR TEST PROGRAM

DATE....2-21-80..... RUN.Initial Baseline

TEMP....72°F..50%RH.. SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9772	.2977	.3086	.323	-3.555
	-99.7863	.594	.6153	.626	-3.453
	-149.725	.8933	.9227	.868	-3.189
	-199.543	1.1952	1.2294	1.008	-2.777
*	-249.421	1.5011	1.5364	1.042	-2.298
	-299.279	1.8115	1.8433	.94	-1.728
	-349.155	2.1272	2.1504	.684	-1.078
	-399.025	2.4486	2.4574	.259	-.357
	-448.908	2.7762	2.7645	-.346	.424
	-498.769	3.1088	3.0714	-1.103	1.216
	-548.666	3.44492	3.37865	-1.957	1.962
	-498.778	3.1093	3.0715	-1.117	1.232
	-448.879	2.7775	2.7643	-.391	.479
	-399.065	2.4508	2.4576	.202	-.278
	-349.214	2.1299	2.1508	.617	-.971
	-299.287	1.8144	1.8434	.857	-1.576
	-249.445	1.504	1.5366	.962	-2.121
	-199.527	1.1979	1.2293	.927	-2.555
	-149.715	.8959	.9226	.789	-2.898
	-99.7643	.5962	.6151	.559	-3.081
	-49.9782	.2985	.3086	.3	-3.305
	49.8389	-.2951	-.3059	-.316	-3.49
	99.7213	-.5926	-.6129	-.602	-3.318
	149.615	-.8923	-.9201	-.821	-3.019
	199.41	-1.1942	-1.2266	-.958	-2.643
	249.344	-1.5001	-1.534	-1.003	-2.212
	299.168	-1.8101	-1.8408	-.907	-1.667
	349.094	-2.1251	-2.1481	-.678	-1.069
*	398.914	-2.4456	-2.4548	-.271	-.374
	448.85	-2.772	-2.7622	.289	.355
	498.659	-3.1036	-3.0688	1.026	1.131
	548.515	-3.43916	-3.3757	1.874	1.879
	498.693	-3.1043	-3.069	1.042	1.149
	448.814	-2.7736	-2.762	.344	.422
	398.953	-2.4482	-2.455	-.202	-.279
	349.129	-2.1276	-2.1483	-.612	-.963
	299.188	-1.8123	-1.8409	-.843	-1.549
	249.324	-1.5023	-1.5339	-.932	-2.056
	199.447	-1.1964	-1.2269	-.899	-2.478
	149.654	-.8944	-.9203	-.764	-2.809
	99.7027	-.5945	-.6128	-.542	-2.989
	49.8288	-.2965	-.3058	-.274	-3.028

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550
SCALE FACTOR (V/DEG/SEC): -6.15610E-03
BIAS (VOLTS) : 9.52902E-04
HYSTERESIS, NEG RATES (VDC): -2.85959E-03
HYSTERESIS, POS RATES (VDC): 2.57397E-03

TABLE 3.1.2-V

TEST ENGINEER.....2/21/80

RATE SENSOR TEST PROGRAM

DATE...2-21-80..... RUN.Initial Baseline..... NADC 80081-60

TEMP...72° F...50%RH..... SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9646	.2978	.3105	.342	-4.11
	-99.8151	.5948	.6193	.659	-3.958
	-149.69	.8941	.9282	.917	-3.674
*	-199.492	1.1965	1.2366	1.08	-3.247
	-249.402	1.5028	1.5457	1.155	-2.778
	-299.306	1.8132	1.8548	1.12	-2.245
	-349.142	2.1292	2.1635	.921	-1.583
	-398.988	2.4506	2.4722	.582	-.875
	-449.006	2.7779	2.782	.11	-.148
	-498.82	3.1105	3.0905	-.538	.647
	-548.624	3.44725	3.39903	-1.298	1.419
	-598.524	3.78638	3.70809	-2.107	2.112
	-548.659	3.44843	3.39925	-1.324	1.447
	-498.79	3.1123	3.0903	-.591	.71
	-448.879	2.7802	2.7812	.027	-.036
	-399.103	2.4531	2.4729	.532	-.8
	-349.137	2.1316	2.1634	.858	-1.475
	-299.338	1.8155	1.855	1.064	-2.132
	-249.424	1.5052	1.5459	1.095	-2.635
	-199.524	1.1991	1.2368	1.015	-3.053
	-149.666	.8963	.928	.853	-3.419
	-99.8218	.5965	.6193	.613	-3.683
	-49.9053	.2987	.3101	.308	-3.702
	49.8445	-.2957	-.3077	-.321	-3.87
	99.7399	-.5934	-.6167	-.627	-3.772
	149.561	-.8934	-.9253	-.859	-3.444
*	199.42	-1.1955	-1.2341	-1.039	-3.126
	249.337	-1.5016	-1.5432	-1.12	-2.694
	299.178	-1.812	-1.8519	-1.075	-2.156
	349.044	-2.1274	-2.1608	-.899	-1.546
	398.884	-2.4478	-2.4695	-.583	-.877
	448.799	-2.7745	-2.7786	-.111	-.149
	498.743	-3.1059	-3.088	.484	.582
	548.62	-3.44174	-3.39681	1.209	1.322
	598.466	-3.77955	-3.70554	1.992	1.997
	548.562	-3.4427	-3.39646	1.244	1.361
	498.721	-3.1075	-3.0878	.529	.636
	448.857	-2.7759	-2.779	-.083	-.111
	398.899	-2.4497	-2.4696	-.533	-.802
	349.051	-2.1292	-2.1608	-.851	-1.463
	299.198	-1.8139	-1.8521	-1.027	-2.06
	249.344	-1.5038	-1.5433	-1.062	-2.556
	199.464	-1.1977	-1.2343	-.986	-2.966
	149.632	-.8952	-.9257	-.822	-3.296
	99.6367	-.5952	-.6161	-.563	-3.388
	49.8377	-.2969	-.3076	-.288	-3.47

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 600
SCALE FACTOR (V/DEG/SEC): -6.19356E-03
BIAS (VOLTS) : 1.04026E-03
HYSTERESIS, NEG RATES (VDC): -2.58541E-03
HYSTERESIS, POS RATES (VDC): 2.23064E-03

TABLE 3.1.2-VI

TEST ENGINEER.....

2-21-80

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

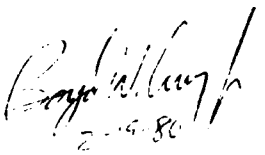
DATE...2-19-80..... RUN.Initial Baseline

TEMP...72°F....50%RH SER#....355.....

OUTPUT DRIFT IN 15 SEC INTERVALS

TIME (SEC)	RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
15	99.8056	.592772	5.93927E-03
30	99.8325	.59322	5.94215E-03
45	99.8305	.59357	5.94578E-03
60	99.8634	.594153	5.94966E-03
15	199.592	1.18991	5.96172E-03
30	199.557	1.19068	5.96663E-03
45	199.567	1.19153	5.97059E-03
60	199.59	1.19221	5.97330E-03
15	299.339	1.80431	6.02766E-03
30	299.342	1.80549	6.03154E-03
45	299.337	1.80621	6.03404E-03
60	299.318	1.80705	6.03723E-03
15	399.056	2.44222	6.11999E-03
30	399.09	2.44294	6.12126E-03
45	399.065	2.44408	6.12452E-03
60	399.112	2.44519	6.12658E-03
15	498.868	3.10689	6.22788E-03
30	498.909	3.1081	6.22980E-03
45	498.824	3.10925	6.23316E-03
60	498.847	3.11066	6.23569E-03

READY



*Data Shown are for t = 15, 30, 45, and 60 seconds for each of five nominal rate inputs of 100, 200, 300, 400, and 500 degrees/second.

TABLE 3.1.2-VII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE..2-19-80..... RUN..Initial Baseline

TEMP..72°F..50%RH.. SER#...373.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8112	.591919	5.93039E-03
99.864	.592952	5.93760E-03
99.8498	.593578	5.94471E-03
99.8284	.594043	5.95064E-03
199.589	1.20507	6.03772E-03
199.578	1.20608	6.04316E-03
199.581	1.20674	6.04638E-03
199.538	1.20752	6.05156E-03
299.308	1.84101	6.15090E-03
299.316	1.84205	6.15420E-03
299.338	1.8429	6.15659E-03
299.338	1.84376	6.15946E-03
399.1	2.50633	6.27997E-03
399.115	2.50797	6.28383E-03
399.072	2.50887	6.28676E-03
399.079	2.50979	6.28896E-03
498.88	3.20376	6.42191E-03
498.89	3.20515	6.42456E-03
498.908	3.20679	6.42761E-03
498.927	3.20789	6.42958E-03

READY

TABLE 3.1.2-VIII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE...2-19-80..... RUN.Initial Baseline

TEMP..72°F...50%RH.. SER#...381.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8467	.592919	5.93829E-03
99.7802	.593474	5.94781E-03
99.8533	.593904	5.94777E-03
99.7711	.594278	5.95642E-03
199.599	1.19523	5.98817E-03
199.61	1.19608	5.99208E-03
199.599	1.19674	5.99573E-03
199.583	1.19772	6.00113E-03
299.316	1.81507	6.06406E-03
299.346	1.81605	6.06674E-03
299.359	1.81723	6.07042E-03
299.322	1.81789	6.07336E-03
399.073	2.45741	6.15779E-03
399.069	2.45848	6.16053E-03
399.103	2.45948	6.16253E-03
399.071	2.46072	6.16613E-03
498.804	3.12312	6.26122E-03
498.83	3.12489	6.26444E-03
498.83	3.1261	6.26687E-03
498.859	3.12645	6.26720E-03

READY

2-19-80

TABLE 3.1.2-IX

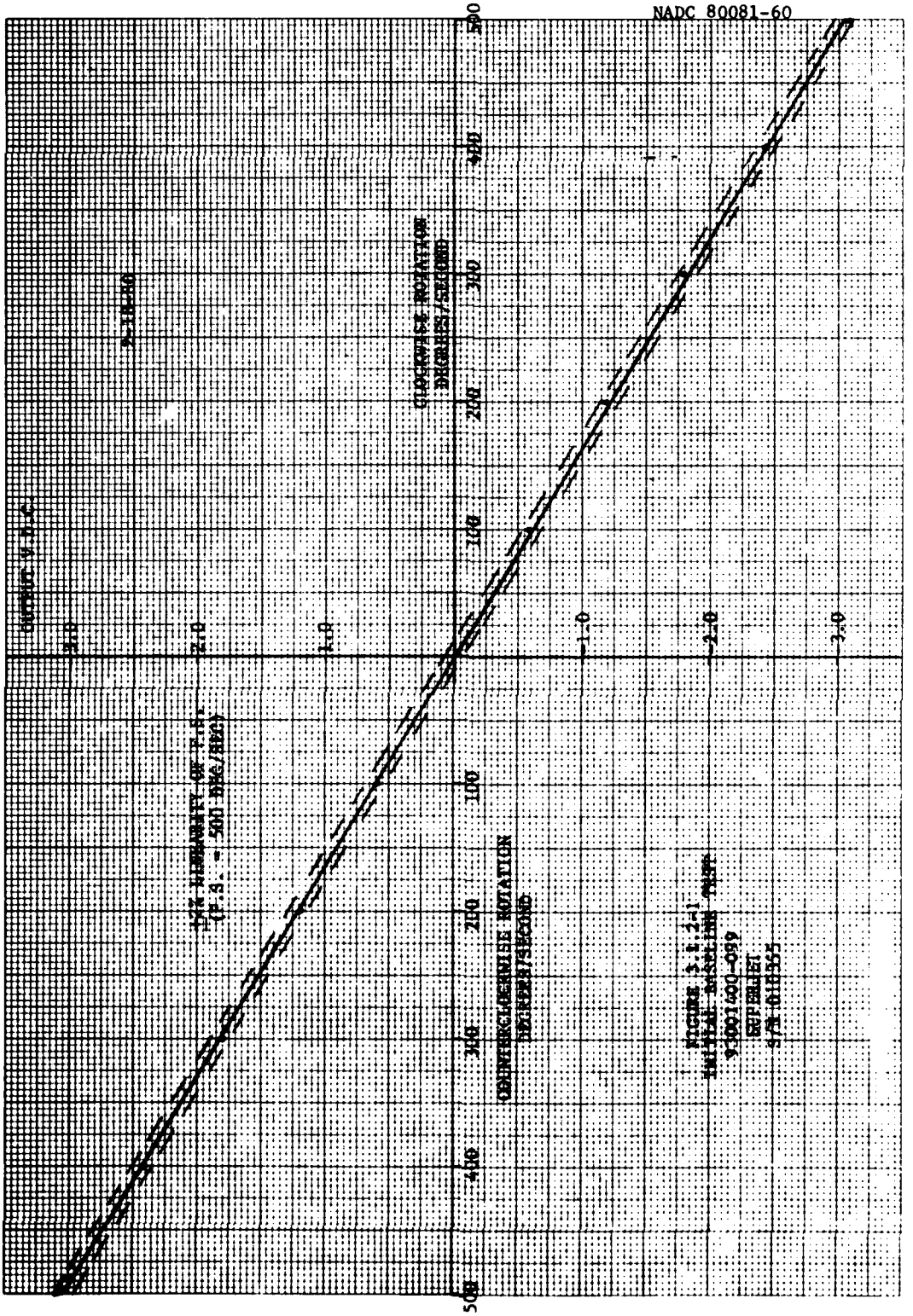


FIGURE 3.1.2.1
INITIAL BASELINE DATA
9.0001600-059
BUREAU
A/R 018855

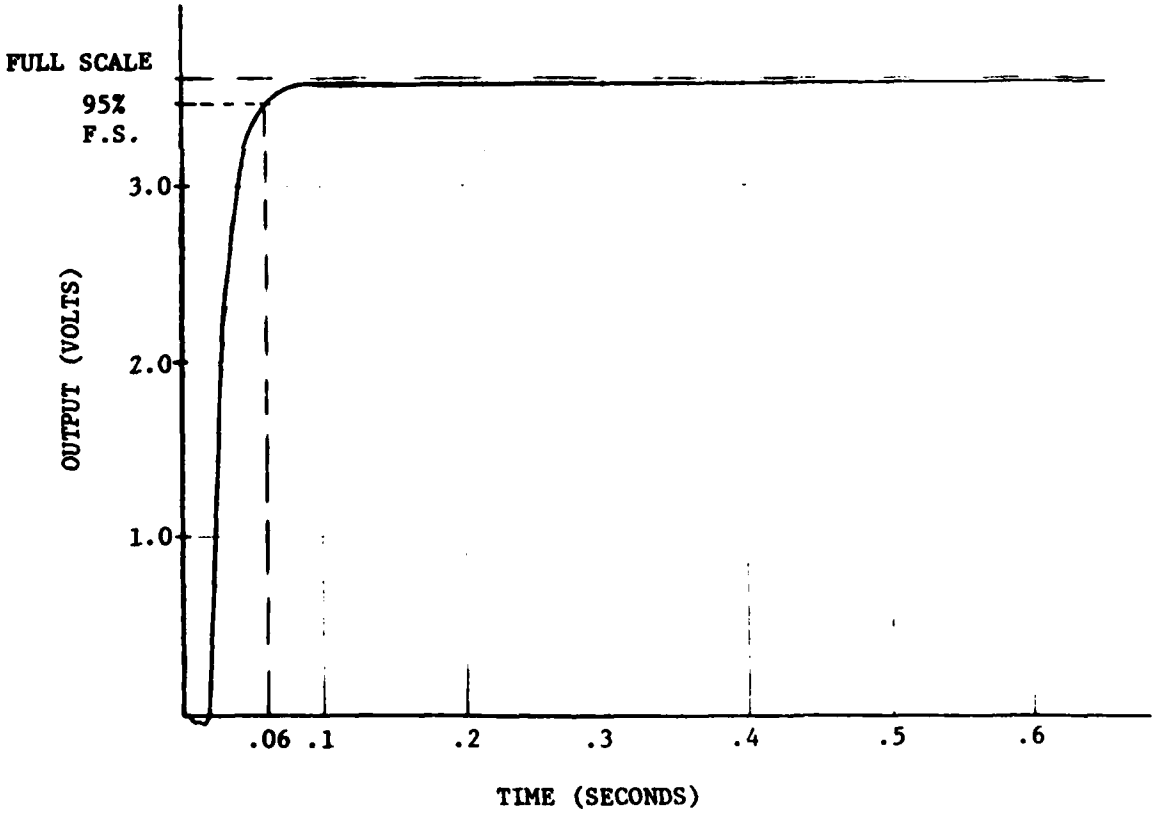


FIGURE 3.1.2-2

TYPICAL READYTIME PLOT

PARAMETER	S/N 355	S/N 373	S/N 381
FULL SCALE RATE (DEG/SECOND) AT ±2% LINEARITY ERROR	500	400	550
SCALE FACTOR (MV/DEG/SEC)	-6.08	-6.15	-6.15
BIAS (DEG/SECOND)	-.26	+.22	-.15
HYSTERESIS CCW (DEG/SECOND)	+.56	+.34	+.47
HYSTERESIS CW (DEG/SECOND)	-.37	-.30	-.42
THRESHOLD (DEG/SECOND)	<.10	<.10	<.10
RESOLUTION (DEG/SECOND)	<.10	<.10	<.10
READYTIME (SECONDS) AVG. OF 5 RATES*	+.038	+.050	+.047
DRIFT (DEG/SEC/MIN) AVG. OF 5 RATES*	+.22	+.19	+.18

*100, 200, 300, 400, AND 500 DEGREES/SECOND
(See Table 3.1.3-II)

TABLE 3.1.3-I

BASELINE TEST DATA SUMMARY

RATE (DEG/SEC)	OUTPUT DRIFT (DEG/SEC/MIN)			READYTIME (SECONDS)		
	355	373	381	355	373	381
100	+.22	+.33	+.29	.032	.035	.045
200	+.25	+.23	+.21	.035	.045	.035
300	+.31	+.14	+.15	.035	.050	.045
400	+.14	+.14	+.13	.040	.068	.045
500	+.17	+.13	+.10	.046	.055	.065

TABLE 3.1.3-II

BASELINE DRIFT AND READYTIME

3.2 Acceleration Sensitivity

3.2.1 Test Setup and Procedure

The "Superjet" rate sensors (one at a time) were mounted on the Genisco model 1100-2 rate table in the Precision Inertial Laboratory. The rate table was again controlled by the Hewlett Packard 9500A test set. The scale factor test program (see Section 3.1) was used and a maximum rate of 500 degrees/second was used as a baseline. The rate sensors were subjected to constant accelerations in each direction along the three mutually perpendicular axes, (See Figure B.2-1 in Appendix A).

The X and Y axes were accelerated with the input axis or Z axis of the sensor parallel to the rate table spin axis. The Z axis was accelerated with the X axis or jet axis parallel to the rate table spin axis.

The acceleration tests were conducted per Appendix A Part B of this test report. The tests deviate from the test plan (Appendix B) for which the desired maximum acceleration level was 30g.

Due to the saturation of the "Superjet" exceeding a 2% error beyond 500 degrees/second, the maximum acceleration applied was 4.74g which is equivalent to a rate of 500 degrees/second.

The orientation of Superjet while subjected to acceleration was made to be rate sensitive. The manufacturer performed acceleration tests with the Superjet oriented to be rate in-sensitive. The performance of the "Maximum Performance Escape System" depends on the g-sensitivity in any direction of acceleration, where the worst case appears to be a rate sensitive orientation.

3.2.2 Test Results

By using the scale factor test program, the voltage output of the "Superjet" was recorded at 250 and 500 degrees per second. This was done for six different orientations at a zero arm and approximately a twenty-four inch arm. The data used for the X and Y axis at the zero arm was obtained from the baseline post acoustic test results, (see Tables 3.5.2-I, IV and V). Tables 3.2.2-I through 3.2.2-XXI represent data obtained during testing for each axis accelerated. Using the underlined values, Table 3.2.2-XXII was constructed for evaluation.

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..+X R=24 in..

TEMP..72°F 50%RH... SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-500.0432	.3045	.3149	.334	-3.334
	-99.8811	.6065	.626	.627	-3.14
	-149.813	.9115	.9378	.842	-2.81
*	-199.697	1.2192	1.2492	.956	-2.4
	-249.684	1.5314	1.5636	.942	-1.966
	-299.477	1.8485	1.878	.753	-1.258
	-349.399	2.1715	2.1837	.391	-.56
	-399.313	2.5005	2.4953	-.168	.21
	-449.182	2.8362	2.8066	-.947	1.054
	-499.093	3.1784	3.1162	-1.989	1.933
	-449.248	2.837	2.807	-.96	1.069
	-399.284	2.5019	2.4951	-.218	.273
	-349.368	2.1732	2.1835	.33	-.473
	-299.517	1.8508	1.8723	.688	-1.148
	-249.583	1.534	1.5636	.852	-1.707
	-199.715	1.2218	1.2493	.879	-2.2
	-149.778	.914	.9375	.756	-2.522
	-99.8777	.6086	.626	.559	-2.787
	-50.01	.3355	.3147	.295	-2.949
	49.7883	-.299	-.3383	-.299	-2.999
	99.6847	-.6019	-.6197	-.578	-2.367
	149.577	-.9073	-.9312	-.767	-2.565
*	199.439	-1.2149	-1.2425	-.885	-2.212
	249.349	-1.5266	-1.5541	-.879	-1.762
	299.246	-1.8429	-1.8655	-.726	-1.213
	349.175	-2.1643	-2.1772	-.414	-.595
	399.334	-2.4913	-2.4883	.098	.122
	448.84	-2.825	-2.8	.831	.899
	498.821	-3.165	-3.1114	1.715	1.72
	448.88	-2.8264	-2.7997	.858	.956
	399.351	-2.4933	-2.4886	.152	.191
	349.133	-2.1666	-2.177	-.334	-.478
	299.228	-1.8449	-1.8654	-.657	-1.398
	249.407	-1.5292	-1.5544	-.887	-1.611
	199.456	-1.2175	-1.2426	-.838	-2.311
	149.571	-.9095	-.9312	-.695	-2.324
	99.6892	-.6038	-.6198	-.511	-2.564
	49.7856	-.3051	-.3383	-.261	-2.681

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.0026[illegible]E-03

BIAS (VOLTS) : 2.5[illegible]E-03

HYSTERESIS, NEG RATES (VDC): -2.6[illegible]E-03

HYSTERESIS, POS RATES (VDC): 2.67[illegible]E-03

FULL OFFSET (VDC): 3.95[illegible]E-03

TEST ENGINEER Boyd W. Cummings

DATE: 3-28-80

READY

TABLE 3.2.2-I

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..-X...R-24.in..

TEMP..72°F...50%RH.. SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-549.3125	.3036	.3149	.361	-3.613
	-99.8789	.6055	.6258	.653	-3.278
	-149.773	.9102	.9371	.963	-2.882
	-199.648	1.2181	1.2481	.962	-2.41
*	-249.61	1.53	1.5597	.853	-1.909
	-299.461	1.8474	1.8736	.745	-1.844
	-349.382	2.1698	2.182	.411	-.588
	-399.316	2.498	2.4934	-.146	.193
	-449.181	2.8333	2.804	-.938	1.344
	-498.298	3.1748	3.1157	-1.893	1.196
	-449.288	2.8347	2.835	-.952	1.36
	-399.28	2.5005	2.4932	-.834	.293
	-349.45	2.173	2.1824	.332	-.433
	-299.5	1.851	1.8739	.637	-1.064
	-249.576	1.5347	1.5585	.798	-1.598
	-199.68	1.2226	1.2483	.806	-2.368
	-149.78	.9146	.9372	.705	-2.482
	-99.854	.6094	.6257	.523	-2.601
	-49.9917	.3061	.3142	.077	-2.778
	49.7846	-.2983	-.3375	-.894	-2.955
	99.7146	-.6013	-.6185	-.564	-2.83
*	149.568	-.9062	-.9289	-.76	-2.54
	199.444	-1.2141	-1.2469	-.859	-2.154
	249.366	-1.5256	-1.5583	-.85	-1.734
	299.3	-1.8414	-1.8697	-.719	-1.197
	349.231	-2.1622	-2.1751	-.413	-.591
	399.341	-2.4857	-2.4858	.096	.12
	449.326	-2.8017	-2.7975	.777	.866
	498.928	-3.1636	-3.1387	1.662	1.666
	448.965	-2.8229	-2.7971	.886	.98
	399.111	-2.4934	-2.4862	.136	.17
	349.165	-2.1645	-2.1747	-.326	-.467
	299.249	-1.8436	-1.8634	-.635	-1.36
	249.442	-1.5282	-1.5527	-.786	-1.575
	199.503	-1.2168	-1.2413	-.785	-1.968
	149.631	-.9089	-.9301	-.678	-2.265
	99.6621	-.6039	-.6186	-.472	-2.368
	49.8181	-.3004	-.3077	-.234	-2.353

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.23678E-03

BIAS (VOLTS) : 2.96044E-03

HYSTERESIS, NEG RATES (VDC): -4.64278E-03

HYSTERESIS, POS RATES (VDC): 2.67529E-03

NULL OFFSET (VDC): 3.54195E-03

TEST ENGINEER.....

3-28-80

READY

TABLE 3.2.2-II

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 3-28-80 RUN TEV 8-24-to

TEMP 72°F 530°R SER# 355

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-500.001	.3033	.3136	.332	-3.323
	-399.9149	.6044	.6238	.624	-3.105
	-149.8	.9379	.9339	.837	-2.794
*	-199.656	1.2143	1.2437	.949	-2.376
	-249.573	1.5052	1.554	.926	-1.855
	-299.35	1.8408	1.8634	.725	-1.211
	-349.34	2.1615	2.1741	.403	-.577
	-399.206	2.4894	2.484	-.173	.217
	-449.283	2.8234	2.7948	-.921	1.325
	-499.888	3.1643	3.1044	-1.926	1.93
	-449.186	2.8246	2.7943	-.975	1.385
	-399.886	2.4912	2.4841	-.288	.285
	-349.373	2.1642	2.1743	.324	-.464
	-299.489	1.8434	1.8642	.672	-1.121
	-249.558	1.5281	1.5539	.831	-1.665
	-199.686	1.2173	1.2439	.856	-2.144
	-149.83	.9107	.9341	.752	-2.511
	-99.9183	.6064	.6238	.56	-2.832
	-49.9929	.3043	.3135	.297	-2.968
	49.7981	-.296	-.3067	-.28	-2.812
	99.6316	-.5998	-.6164	-.536	-2.689
	149.556	-.9337	-.9267	-.741	-2.476
	199.452	-1.2122	-1.2368	-.858	-2.151
*	249.334	-1.5233	-1.5469	-.854	-1.713
	299.229	-1.8348	-1.857	-.714	-1.193
	349.117	-2.1546	-2.1671	-.4	-.572
	399.367	-2.4799	-2.4775	.077	.397
	448.685	-2.8116	-2.7871	.788	.877
	498.784	-3.149	-3.0973	1.665	1.67
	448.982	-2.8125	-2.7877	.795	.886
	398.992	-2.4812	-2.477	.135	.17
	349.141	-2.1566	-2.1672	-.34	-.487
	299.239	-1.837	-1.857	-.644	-1.377
	249.379	-1.5229	-1.5472	-.782	-1.568
	199.469	-1.2125	-1.2369	-.785	-1.968
	149.569	-.9058	-.9268	-.676	-2.26
	99.6486	-.6317	-.6165	-.478	-2.389
	49.7961	-.2998	-.3067	-.24	-2.406

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500
SCALE FACTOR (V/DEG/SEC): -6.21531E-03
BIAS (VOLTS) : 2.81463E-03
HYSTERESIS, NEG RATES (VDC): -3.07298E-03
HYSTERESIS, POS RATES (VDC): 2.52247E-03
NULL OFFSET (VDC): 3.5172ME-03

TEST ENGINEER [signature] 3-28-80

READY

TABLE 3.2.2-III

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..7-X...R24.in..

TEMP..72°F...50%RH.. SER#....355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9885	.3022	.312	.316	-3.161
	-99.8354	.6034	.6224	.612	-3.067
*	-149.676	.937	.9324	.817	-2.73
	-199.585	1.2139	1.2427	.93	-2.309
	-249.5	1.5047	1.5532	.915	-1.834
	-299.439	1.84	1.8636	.758	-1.265
	-349.388	2.1613	2.1738	.434	-.579
	-399.25	2.4864	2.4845	-.125	.156
	-449.316	2.8224	2.794	-.914	1.318
	-498.935	3.1626	3.1044	-1.87	1.874
	-449.391	2.8238	2.7944	-.926	1.331
	-399.143	2.4899	2.4838	-.197	.247
	-349.338	2.1635	2.1741	.34	-.487
	-299.367	1.8426	1.8633	.666	-1.113
	-249.549	1.5274	1.5535	.84	-1.682
	-199.626	1.2166	1.243	.651	-2.131
	-149.739	.9397	.9328	.742	-2.477
	-99.7728	.6359	.622	.519	-2.601
	-49.9333	.3439	.3101	.265	-2.652
	49.8621	-.2993	-.3035	-.308	-3.092
	99.7327	-.6083	-.6185	-.585	-2.933
	149.667	-.9343	-.9293	-.824	-2.687
*	199.493	-1.2113	-1.2391	-.993	-2.237
	249.456	-1.5022	-1.5498	-.868	-1.781
	299.28	-1.8371	-1.8596	-.726	-1.212
	349.165	-2.1577	-2.17	-.396	-.567
	399.373	-2.4841	-2.4803	.123	.154
	449.411	-2.8171	-2.7928	.844	.94
	498.914	-3.1554	-3.1312	1.744	1.748
	449.362	-2.8178	-2.7911	.857	.954
	399.137	-2.4858	-2.4805	.17	.213
	349.188	-2.1632	-2.17	-.317	-.453
	299.374	-1.8402	-1.8632	-.645	-1.078
	249.473	-1.5251	-1.5499	-.797	-1.597
	199.539	-1.2145	-1.2394	-.831	-2.337
	149.655	-.9073	-.9291	-.702	-2.346
	99.7619	-.6027	-.6189	-.519	-2.601
	49.8765	-.2999	-.3086	-.279	-2.801

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.21895E-03

BIAS (VOLTS) : 1.55324E-03

HYSTERESIS, NEG RATES (VDC): -2.73639E-03

HYSTERESIS, POS RATES (VDC): 3.13735E-03

FULL OFFSET (VDC): 2.94272E-03

TEST ENGINEER Boyd W. Cary

3-28-80

READY

TABLE 3.2.2-IV

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 4-14-80 RUN +Z, R=23.6 in.

TEMP. 72°F 50%RH SER# 355

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9384	.0043	.0035	-1.249	13.536
	-99.8117	-.0011	-.001	-.33	1.653
	-149.693	-.0026	-.0025	-.712	2.379
	-199.578	-.004	-.004	.137	-.343
	-249.58	-.0054	-.0056	.955	-1.914
	-299.489	-.0068	-.0071	1.841	-3.175
	-349.341	-.0083	-.0086	2.161	-3.093
	-399.199	-.0097	-.0101	2.774	-3.475
	-449.05	-.0111	-.0116	3.412	-3.799
	-499.313	-.0125	-.0131	3.836	-3.814
	-449.398	-.0111	-.0116	3.142	-3.498
	-399.142	-.0098	-.0101	2.11	-2.644
	-349.353	-.0084	-.0086	1.374	-1.967
	-299.389	-.007	-.0071	.298	-.498
	-249.556	-.0056	-.0056	-.47	.942
	-199.637	-.0043	-.004	-1.768	4.429
	-149.683	-.003	-.0025	-3.385	13.335
	-99.8489	-.0015	-.001	-3.456	17.336
	-49.9511	-.0000	.0035	-4.394	43.9603
*	49.8931	.0026	.0035	-5.981	-59.9346
	99.7586	.0041	.005	-5.935	-29.747
	149.733	.0057	.0065	-5.749	-19.231
	199.578	.0074	.008	-4.571	-11.459
	249.508	.009	.0096	-3.716	-7.439
	299.363	.0107	.0111	-2.197	-3.669
	349.342	.0126	.0126	.041	.059
	399.133	.0144	.0141	2.034	2.761
	449.099	.0164	.0156	5.265	5.999
	498.908	.0184	.0171	8.681	8.7
	449.171	.0165	.0156	5.779	6.433
	399.158	.0146	.0141	3.542	4.437
	349.344	.0128	.0126	1.603	2.323
	299.387	.0111	.0111	.539	.941
	249.559	.0095	.0096	-.474	-.951
	199.611	.0078	.008	-1.379	-3.455
	149.677	.0063	.0065	-1.478	-4.938
	99.7856	.0048	.005	-1.463	-7.309
	49.9022	.0033	.0035	-1.483	-14.86

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 3.02811E-05

BIAS (VOLTS) : 1.99878E-03

HYSTERESIS, NEG RATES (VDC): -9.99934E-09

HYSTERESIS, POS RATES (VDC): 0

NULL OFFSET (VDC): 2.13032E-03

TEST ENGINEER [signature] 3-28-80

READY

TABLE 3.2.2-V

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..4-1-80..... RUN..2..8424.4.in.

TEMP..72°F..50%RH. SER#..355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9478	.0033	.0034	-1.126	11.273
	-99.8489	-.001	-.0009	-.978	4.896
	-149.758	-.0024	-.0021	-1.975	6.259
	-199.588	-.0037	-.0034	-2.313	5.795
	-249.553	-.0048	-.0046	-1.573	3.152
	-299.434	-.006	-.0059	-.585	.977
	-349.397	-.0071	-.0072	.029	-1.187
	-399.309	-.0081	-.0084	2.566	-3.213
	-449.317	-.0091	-.0097	4.971	-5.536
	-499.488	-.0099	-.0109	7.346	-8.363
	-449.348	-.0091	-.0097	4.568	-5.356
	-399.194	-.0082	-.0084	1.65	-2.367
	-349.225	-.0072	-.0072	-.327	.469
	-299.388	-.0062	-.0059	-2.138	3.571
	-249.424	-.005	-.0046	-3.049	6.119
	-199.654	-.0039	-.0034	-3.983	9.725
	-149.741	-.0026	-.0021	-3.926	13.131
	-99.8488	-.0014	-.0009	-4.17	21.864
	-49.9391	-.0001	.0004	-3.776	37.8284
*	49.6665	.0026	.0029	-2.484	-24.91
	99.7558	.0039	.0042	-1.926	-9.653
	149.621	.0054	.0054	-.764	-2.552
	199.491	.0067	.0067	.021	.735
	249.418	.0081	.008	1.051	2.537
	299.297	.0094	.0092	1.636	2.684
	349.239	.0106	.0105	2.072	2.967
	399.105	.012	.0118	1.855	2.324
	449.109	.0132	.013	1.678	1.956
	498.846	.0144	.0143	1.185	1.187
	449.112	.0132	.013	1.824	2.33
	399.387	.012	.0118	2.079	2.634
	349.222	.0107	.0105	1.529	2.129
	299.368	.0094	.0092	1.535	2.563
	249.457	.0081	.008	.636	1.274
	199.62	.0067	.0067	-.445	-1.115
	149.723	.0053	.0055	-1.338	-3.368
	99.723	.004	.0042	-1.638	-8.214
	49.8884	.0026	.0029	-2.414	-24.2

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 2.507488E-05

BIAS (VOLTS) : 1.666162E-03

HYSTERESIS, NEG RATES (VDC): -9.999999E-09

HYSTERESIS, POS RATES (VDC): 9.859594E-05

NULL OFFSET (VDC): 2.231651E-03

TEST ENGINEER

4-1-80

READY

TABLE 3.2.2-VI

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE. 4-1-80..... RUN. 2 ... R-0.16...

TEMP. 72°F / 50%RH.. SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9239	.0001	0	1.435	-14.368
	-99.7863	-.0004	-.0005	2.369	-11.97
	-149.72	-.0011	-.001	-1.069	3.571
	-199.654	-.0016	-.0015	-.956	2.393
	-249.556	-.002	-.002	-.398	.196
	-299.431	-.0025	-.0026	.402	-.678
	-349.402	-.003	-.0031	1.266	-1.811
	-399.296	-.0034	-.0036	3.345	-3.913
	-449.209	-.0038	-.0041	5.263	-5.858
	-499.05	-.0043	-.0046	6.516	-6.53
	-449.213	-.0039	-.0041	4.597	-5.116
	-399.236	-.0035	-.0036	2.153	-2.696
	-349.379	-.003	-.0031	.692	-.99
	-299.399	-.0026	-.0026	-1.095	1.828
	-249.587	-.0022	-.002	-2.497	5.031
	-199.641	-.0017	-.0015	-3.158	7.91
	-149.822	-.0012	-.001	-4.216	14.072
	-99.8371	-.0007	-.0005	-4.726	23.67
	-49.9398	-.0003	0	-5.484	54.9018
	49.8831	.0007	.0011	-6.884	-68.9773
	99.7856	.0013	.0016	-5.17	-25.945
	149.677	.0019	.0021	-4.389	-13.66
	199.572	.0024	.0026	-3.987	-9.838
	249.532	.0031	.0031	-1.43	-2.865
	299.469	.0036	.0037	-.293	-.49
	349.266	.0043	.0042	1.525	2.183
	399.231	.0048	.0047	2.936	3.677
*	449.114	.0055	.0052	4.996	5.562
	499.112	.006	.0057	6.341	6.351
	449.126	.0055	.0052	4.871	5.423
	399.21	.0049	.0047	3.548	4.444
	349.32	.0043	.0042	2.007	2.872
	299.427	.0037	.0037	.675	1.128
	249.54	.0031	.0031	-.632	-1.067
	199.583	.0025	.0026	-1.717	-4.302
	149.696	.002	.0021	-2.893	-9.664
	99.7636	.0015	.0016	-1.982	-9.934
	49.8821	.0009	.0011	-2.641	-26.473

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 1.0367ØE-Ø5

BIAS (VOLTS) : 5.5ØØ41E-Ø4

HYSTERESIS, NEG RATES (VDC): -8.9998ØE-Ø9

HYSTERESIS, POS RATES (VDC): 6.34789E-Ø6

NULL OFFSET (VDC): 9.868Ø3E-Ø4

TEST ENGINEER Boyd W. Crump

4-1-80

READY

TABLE 3.2.2-VII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 3-28-80 RUN PK R-44 1p2

TEMP 72°F 50%RH SER# 373

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9921	.2975	.3151	.559	-5.587
	-99.9268	.6023	.6311	.91	-4.551
	-149.756	.9106	.9464	1.132	-3.779
	-199.685	1.2228	1.2603	1.25	-3.128
*	-249.512	1.5407	1.5776	1.165	-2.335
	-299.519	1.8652	1.894	.91	-1.519
	-349.399	2.1968	2.2096	.407	-.582
	-399.269	2.5363	2.5252	-.353	.442
	-449.211	2.884	2.8412	-1.355	1.536
	-499.125	3.2383	3.157	-2.569	2.574
	-449.211	2.8851	2.8412	-1.387	1.544
	-399.35	2.5378	2.5257	-.382	.479
	-349.411	2.1986	2.2097	.351	-.508
	-299.49	1.8668	1.8938	.854	-1.425
	-249.634	1.5429	1.5782	1.116	-2.235
	-199.708	1.2247	1.2624	1.192	-2.985
	-149.813	.9122	.9462	1.074	-3.65
	-99.8929	.6041	.6309	.846	-4.232
	-50.3342	.2986	.3154	.532	-5.319
	49.7701	-.3094	-.3161	-.212	-2.126
	99.6431	-.6136	-.6316	-.564	-2.83
	149.591	-.9205	-.9477	-.86	-2.87
	199.437	-1.2347	-1.2631	-1.005	-2.571
*	249.412	-1.5453	-1.5794	-1.076	-2.156
	299.358	-1.8659	-1.8947	-.91	-1.521
	349.189	-2.1938	-2.2103	-.54	-.774
	399.024	-2.5274	-2.526	.345	.356
	448.995	-2.8697	-2.8422	.87	.966
	498.926	-3.2187	-3.1581	1.915	1.918
	449.014	-2.8706	-2.8423	.896	.997
	399.107	-2.5285	-2.5264	.307	.384
	349.144	-2.1946	-2.2104	-.498	-.713
	299.268	-1.8677	-1.8948	-.856	-1.43
	249.439	-1.5477	-1.5795	-1.005	-2.014
	199.449	-1.2386	-1.2632	-.967	-2.423
	149.623	-.9223	-.9479	-.838	-2.781
	99.7213	-.6151	-.6322	-.54	-2.71
	49.8417	-.31	-.3163	-.198	-1.981

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.32743E-03

BIAS (VOLTS) : -1.18439E-03

HYSTERESIS, NEG RATES (VDC): -2.14208E-03

HYSTERESIS, POS RATES (VDC): 2.37274E-03

NULL OFFSET (VDC): -5.89595E-03

TEST ENGINEER [signature] 3-28-80

READY

TABLE 3.2.2-VIII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80 87.... RUN..[illegible]..

TEMP..72F./50%RH.. SER#..373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-50.0083	.2985	.3175	.621	-6.035
	-99.8917	.6043	.6342	.944	-4.723
	-149.746	.9141	.9507	1.153	-3.849
*	-199.693	1.2278	1.2672	1.261	-3.158
	-249.59	1.547	1.5846	1.184	-2.372
	-299.443	1.8725	1.9011	.898	-1.5
	-349.411	2.2056	2.2183	.401	-.573
	-399.299	2.5464	2.535	-.359	.45
	-449.277	2.8946	2.8523	-1.334	1.484
	-499.118	3.2494	3.1687	-2.542	2.547
	-449.169	2.8959	2.8516	-1.397	1.555
	-399.186	2.5489	2.5343	-.459	.575
	-349.483	2.2084	2.2187	.325	-.465
	-299.472	1.8757	1.9012	.806	-1.346
	-249.612	1.5502	1.5847	1.106	-2.176
	-199.666	1.2311	1.2676	1.15	-2.88
	-149.727	.9173	.9506	1.048	-3.498
	-99.925	.6073	.6344	.854	-4.272
	-49.9909	.3074	.3174	.537	-5.375
	49.7969	-.3097	-.3161	-.2	-2.337
*	99.6655	-.6154	-.6327	-.546	-2.738
	149.52	-.9235	-.9492	-.848	-2.741
	199.479	-1.2346	-1.2663	-1.101	-2.539
	249.425	-1.5503	-1.5834	-1.044	-2.392
	299.249	-1.8714	-1.8997	-.893	-1.491
	349.178	-2.1994	-2.2167	-.545	-.78
	399.038	-2.5343	-2.5332	.032	.04
	448.953	-2.8763	-2.8501	.803	.917
	498.858	-3.2253	-3.167	1.839	1.843
	449.014	-2.8771	-2.8505	.838	.933
	399.094	-2.5349	-2.5336	.041	.051
	349.153	-2.2307	-2.2166	-.501	-.717
	299.242	-1.8728	-1.8997	-.848	-1.417
	249.425	-1.552	-1.5834	-.991	-1.906
	199.484	-1.2363	-1.2664	-.947	-2.373
	149.517	-.9252	-.9498	-.755	-2.504
	99.7112	-.6172	-.633	-.498	-2.497
	49.7937	-.3112	-.3161	-.155	-1.554

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.3485ØE-Ø3

BIAS (VOLTS) : 4.14044E-Ø5

HYSTERESIS, NEG RATES (VDC): -3.35729E-Ø3

HYSTERESIS, POS RATES (VDC): 1.82721E-Ø3

NULL OFFSET (VDC): -5.38325E-Ø3

TEST ENGINEER.....

3-28-80

READY

TABLE 3.2.2-IX

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..+Y, R=24 in..

TEMP..72°F...50%RH.. SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9928	.0991	.3183	.604	-6.341
*	-99.9149	.6055	.6353	.939	-4.699
	-149.727	.9155	.9516	1.137	-3.799
	-199.676	1.2084	1.2688	1.242	-3.111
	-249.576	1.5489	1.5857	1.16	-2.324
	-299.428	1.8744	1.9023	.878	-1.467
	-349.319	2.2061	2.2191	.345	-.493
	-399.214	2.5485	2.5359	-.396	.496
	-449.209	2.8975	2.8534	-1.388	1.545
	-499.315	3.2527	3.1697	-2.615	2.66
	-449.142	2.8977	2.853	-1.436	1.567
	-399.28	2.5489	2.5364	-.396	.496
	-349.306	2.2085	2.219	.332	-.475
	-299.514	1.8753	1.9022	.866	-1.445
	-249.535	1.5496	1.5854	1.13	-2.264
	-199.675	1.2335	1.2688	1.237	-3.324
	-149.764	.9169	.9518	1.1	-3.672
	-99.854	.6071	.6349	.876	-4.366
	-50.3042	.3031	.3183	.575	-5.751
	49.7942	-.3131	-.3154	-.169	-1.697
	99.6689	-.6156	-.6321	-.52	-2.61
	149.593	-.9236	-.9492	-.836	-3.695
*	199.446	-1.2345	-1.2658	-.985	-3.469
	249.358	-1.5532	-1.5827	-1.023	-2.352
	299.3	-1.871	-1.8999	-.938	-1.517
	349.19	-2.199	-2.2167	-.556	-.796
	399.046	-2.5338	-2.5333	.016	.021
	448.926	-2.8761	-2.8501	.82	.914
	498.887	-3.2249	-3.1673	1.812	1.816
	448.977	-2.8766	-2.8504	.805	.919
	399.031	-2.5344	-2.5332	.038	.048
	349.171	-2.2	-2.2166	-.581	-.746
	299.234	-1.8722	-1.8995	-.859	-1.435
	249.386	-1.5513	-1.5829	-.996	-1.597
	199.462	-1.2357	-1.2659	-.95	-2.381
	149.589	-.9246	-.9492	-.774	-2.586
	99.6723	-.6168	-.6322	-.485	-2.433
	49.8113	-.3138	-.3155	-.148	-1.481

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.35036E-03

BIAS (VOLTS) : 7.82692E-04

HYSTERESIS, NEG RATES (VDC): -1.61731E-03

HYSTERESIS, POS RATES (VDC): 1.21004E-03

FULL OFFSET (VDC): -5.73215E-03

TEST ENGINEER Boyd W. Young

3-28-80

READY

TABLE 3.2.2-X

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..#4..R-24 in..

TEMP..72°F...30X#.. SER#...373.....

RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
-49.9245	.296	.313	.536	-5.366
-99.8134	.6035	.6287	.892	-4.466
* -149.734	.9085	.9447	1.143	-3.815
-199.551	1.2208	1.2599	1.238	-3.121
-249.537	1.5385	1.5761	1.186	-2.378
-299.37	1.8626	1.8917	.918	-1.533
-349.878	2.1939	2.2075	.43	-.615
-399.162	2.5328	2.5233	-.334	.38
-449.328	2.8798	2.8388	-1.278	1.423
-498.92	3.2302	3.1545	-2.455	2.46
-449.123	2.881	2.8394	-1.314	1.468
-399.178	2.5349	2.5233	-.366	.461
-349.858	2.1965	2.2074	.345	-.493
-299.373	1.8655	1.8914	.817	-1.365
-249.488	1.5401	1.5759	1.07	-2.145
-199.637	1.2247	1.2603	1.126	-2.53
-149.675	.9184	.9443	1.037	-3.364
-99.8349	.634	.6287	.78	-3.939
-49.9239	.2988	.313	.467	-4.674
49.8534	-.3096	-.3185	-.279	-2.795
99.7656	-.6142	-.6343	-.635	-3.172
149.633	-.9215	-.9491	-.892	-2.988
199.535	-1.232	-1.2653	-1.186	-2.671
249.449	-1.5473	-1.5816	-1.385	-2.174
* 299.338	-1.8679	-1.8972	-.985	-1.545
349.265	-2.1857	-2.2133	-.559	-.8
399.127	-2.5385	-2.5288	.05	.462
448.84	-2.8732	-2.8442	.916	1.221
498.857	-3.2008	-3.1631	1.984	1.986
449.349	-2.8747	-2.8446	.95	1.055
399.131	-2.533	-2.5289	.127	.16
349.196	-2.1986	-2.2129	-.446	-.639
299.351	-1.8715	-1.8975	-.822	-1.378
249.434	-1.5507	-1.5816	-.974	-1.958
199.52	-1.2353	-1.2657	-.959	-2.434
149.652	-.9246	-.9501	-.803	-2.683
99.7947	-.6166	-.6345	-.566	-2.836
49.8871	-.3179	-.3187	-.246	-2.47

TEST SUMMARY

FULL SCAL.. RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.320668E-03

BIAS (VOLTS) : -.002968

HYSTERESIS, NEG RATES (VDC): -3.915191E-03

HYSTERESIS, POS RATES (VDC): 3.533366E-03

NULL OFFSET (VDC): -6.647195E-03

TEST ENGINEER [signature] 3-28-80

READY

TABLE 3.2.2-XI

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..4-1-80..... RUN..+Z...R=23.6 in.

TEMP..72°F..50%RH... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9361	-.0109	-.0118	2.12	-21.226
	-99.7597	-.0156	-.0162	1.348	-6.784
	-149.714	-.0233	-.0236	.659	-2.831
	-199.634	-.025	-.025	-.013	.052
	-249.466	-.0297	-.0283	-.825	1.653
	-299.439	-.0343	-.0337	-1.436	2.345
	-349.279	-.0389	-.0391	-1.842	2.638
	-399.044	-.0434	-.0425	-2.13	2.73
	-449.13	-.0477	-.0469	-2.424	2.253
	-499.333	-.052	-.0512	-1.666	1.671
	-449.172	-.0478	-.0469	-2.358	2.222
	-399.167	-.0435	-.0425	-2.255	2.605
	-349.279	-.0389	-.0381	-1.93	2.763
	-299.431	-.0344	-.0337	-1.441	2.437
	-249.544	-.0297	-.0283	-.848	1.686
	-199.6.4	-.025	-.025	-.159	.399
	-149.717	-.0235	-.02.6	.838	-.784
	-99.8536	-.0157	-.0162	1.257	-6.295
	-49.9403	-.011	-.0119	1.595	-18.966
*	49.9815	-.0019	-.0031	2.765	37.698
	99.696	.0026	.0013	2.897	14.678
	149.694	.007	.0057	2.61	5.652
	199.583	.0113	.0101	2.546	7.13
	249.473	.0154	.0144	2.491	4.191
	299.349	.0197	.0188	.265	1.473
	349.279	.0238	.0232	-1.336	-1.441
	399.138	.0281	.0276	-3.364	-4.213
	449.122	.0324	.032	-5.937	-6.638
	498.928	.0365	.0363	-9.663	-10.688
	449.136	.0325	.032	-5.68	-6.807
	399.259	.0283	.0276	-2.86	-3.519
	349.219	.0231	.0232	-.274	-.383
	299.389	.0186	.0188	1.879	3.139
	249.489	.0159	.0144	3.395	6.833
	199.547	.012	.0101	4.342	10.9
	149.599	.0079	.0057	4.97	16.639
	99.7566	.0035	.0013	5.179	25.454
	49.901	-.001	-.0031	4.791	48.3112

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 8.77455E-05

BIAS (VOLTS) : -7.4543.E-03

HYSTERESIS, NEG RATES (VDC): -9.999.0E-09

HYSTERESIS, POS RATES (VDC): 0

FULL OFFSET (VDC): -0.1614.E-03

TEST ENGINEER [signature] 4-1-80

READY

TABLE 3.2.2-XII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..4-1-80..... RUN..-Z...R=24.4 in.

TEMP..72°F..50%RH... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9338	-.3139	-.3118	2.496	-6.593
	-99.8032	-.3155	-.316	.976	-4.891
	-149.705	-.3241	-.3231	-.25	.169
	-199.563	-.3247	-.3248	-1.183	2.963
	-249.516	-.3292	-.3284	-1.97	3.948
	-299.428	-.3335	-.3325	-2.392	3.995
	-349.213	-.3379	-.3367	-3.349	4.365
	-399.024	-.3419	-.3408	-2.742	3.434
	-449.156	-.3458	-.345	-1.923	2.141
	-499.867	-.3493	-.3491	-.514	.515
	-449.12	-.3457	-.345	-1.826	2.333
	-399.24	-.3419	-.3408	-2.587	3.24
	-349.884	-.3378	-.3367	-2.786	3.573
	-299.414	-.3335	-.3325	-2.39	3.991
	-249.588	-.329	-.3284	-1.454	2.912
	-199.597	-.3244	-.3248	-.439	1.324
	-149.766	-.3198	-.3231	.63	-2.771
	-99.6738	-.3151	-.316	2.441	-14.417
	-49.9519	-.3135	-.3118	3.149	-31.521
*	49.8192	-.3315	-.3035	4.912	48.2341
	99.7556	.3089	.3246	5.389	87.354
	149.698	.327	.3448	5.884	17.657
	199.491	.311	.3609	4.934	18.498
	249.447	.3147	.313	3.675	7.767
	299.271	.3181	.3178	2.237	3.557
	349.293	.3213	.3213	-.371	-.531
	399.163	.3255	.3255	-3.784	-4.74
	449.378	.3265	.3296	-7.614	-8.47
	499	.3289	.3338	-11.754	-11.777
	449.065	.3264	.3296	-7.733	-8.577
	399.112	.3239	.3255	-3.843	-4.815
	349.221	.3211	.3213	-.563	-.836
	299.351	.318	.3178	1.858	3.134
	249.444	.3146	.313	3.715	7.447
	199.493	.3109	.3089	4.737	11.786
	149.572	.3068	.3048	4.971	16.617
	99.8465	.3027	.3006	5.135	25.566
	49.9332	-.3015	-.3035	4.752	47.672

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 6.333475E-05

BIAS (VOLTS) : -7.663454E-03

HYSTERESIS, NEG RATES (VDC): -4.353302E-04

HYSTERESIS, POS RATES (VDC): 1.391992E-04

NULL OFFSET (VDC): -6.369934E-03

TEST ENGINEER: [signature] 4-1-80

READY

TABLE 3.2.2-XIII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..4-1-80..... RUN..Z- R=0 in....

TEMP..72°F...50%RH.. SER#....373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% ES	% IDEAL
	-49.9878	-.0133	-.0119	4.767	-47.6795
*	-99.6488	-.0141	-.0152	3.448	-17.268
	-149.643	-.0178	-.0185	2.117	-6.7
	-199.692	-.0217	-.0218	.278	-.696
	-249.58	-.0255	-.0251	-1.393	2.791
	-299.475	-.0293	-.0284	-2.869	4.78
	-349.431	-.033	-.0317	-4.057	5.806
	-399.343	-.0365	-.0349	-4.795	6.004
	-449.274	-.04	-.0382	-5.321	5.958
	-499.133	-.0433	-.0415	-5.466	5.476
	-449.162	-.04	-.0382	-5.532	6.125
	-399.27	-.0365	-.0349	-4.827	6.32
	-349.433	-.0329	-.0317	-3.905	5.587
	-299.488	-.0292	-.0284	-2.479	4.138
	-249.541	-.0254	-.0251	-.88	1.844
	-199.637	-.0215	-.0218	.714	-1.788
	-149.685	-.0176	-.0185	2.691	-5.999
	-99.854	-.0138	-.0152	4.173	-10.896
	-49.9635	-.0141	-.0119	5.478	-54.1078
	49.8881	-.0098	-.0053	7.676	76.932
	99.7619	-.0035	-.0019	7.745	31.0117
	149.739	.0037	.0018	7.519	25.49
	199.68	.0097	.0145	6.588	10.587
	249.537	.0154	.0278	4.939	9.935
	299.437	.0118	.0111	2.454	3.431
*	349.336	.0139	.0144	-1.547	-2.157
	399.254	.0156	.0177	-6.191	-7.753
	449.139	.0172	.021	-11.581	-12.393
	499.145	.0185	.0243	-17.412	-17.443
	-449.119	.0171	.021	-11.638	-12.957
	399.215	.0156	.0177	-6.288	-7.876
	349.348	.0138	.0144	-1.796	-2.574
	299.448	.0118	.0111	2.231	3.725
	249.548	.0094	.0078	4.844	8.737
	199.631	.0097	.0145	6.618	10.74
	149.637	.0038	.0018	7.78	25.197
	99.811	.0037	-.0019	8.359	41.1709
	49.9461	-.0027	-.0053	7.983	79.976

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 5.11

SCALE FACTOR (V/DEG/SEC): 6.58336E-05

BIAS (VOLTS) : -8.60398E-03

HYSTERESIS, NEG RATES (VDC): -2.38038E-04

HYSTERESIS, POS RATES (VDC): 9.78320E-05

FULL OFFSET (VDC): -6.45833E-03

TEST ENGINEER [signature] 4-1-80

READY

TABLE 3.2.2-XIV

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..+X..R=24 in..

TEMP..72°F..50%RH.. SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9377	.2869	.2857	.285	-2.53
	-99.8574	.5879	.6057	.573	-2.071
	-149.761	.8914	.9155	.778	-2.596
	-199.563	1.1977	1.2247	.907	-2.173
	-249.461	1.5081	1.5346	.853	-1.71
*	-299.392	1.8228	1.8446	.7	-1.169
	-349.884	2.1432	2.1543	.36	-.516
	-399.172	2.4692	2.4641	-.163	.224
	-449.318	2.8005	2.7736	-.867	.966
	-498.95	3.1366	3.0836	-1.705	1.738
	-449.372	2.8314	2.7739	-.884	.984
	-399.157	2.4697	2.464	-.184	.23
	-349.878	2.1442	2.1543	.326	-.467
	-299.412	1.8241	1.8447	.663	-1.137
	-249.47	1.5093	1.5346	.817	-1.637
	-199.582	1.199	1.2249	.833	-2.388
	-149.737	.8924	.9152	.733	-2.447
	-99.81	.589	.6054	.589	-2.648
	-49.9022	.2873	.2955	.266	-2.665
	49.8577	-.3144	-.3039	-.327	-2.374
	99.7984	-.6128	-.6339	-.583	-2.983
	149.713	-.9196	-.9438	-.72	-2.634
	199.531	-1.2269	-1.253	-.963	-2.164
	249.405	-1.5369	-1.563	-.954	-1.712
*	299.358	-1.8519	-1.873	-.721	-1.171
	348.884	-2.1713	-2.1826	-.365	-.503
	399.383	-2.4968	-2.4922	.148	.185
	448.914	-2.8274	-2.8022	.511	.934
	498.884	-3.163	-3.1119	1.646	1.65
	449.338	-2.8287	-2.8022	.954	.99
	399.297	-2.4993	-2.4923	.199	.24
	349.153	-2.1736	-2.1822	-.079	-.389
	299.05	-1.8541	-1.8726	-.595	-.954
	249.476	-1.5392	-1.5633	-.776	-1.556
	199.544	-1.2284	-1.2533	-.[illegible]	-2.[illegible]
	149.678	-.9215	-.9437	-.713	-2.3[illegible]
	99.731	-.6178	-.6334	-.58	-2.[illegible]
	49.8768	-.3147	-.324	-.[illegible]	-3.[illegible]

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.[illegible]94E-03

BIAS (VOLTS) : -1.43357[illegible]-02

HYSTERESIS, NEG RATES (VDC): -1.27[illegible]-03

HYSTERESIS, POS RATES (VDC): 2.[illegible]-03

FULL OFFSET (VDC): -1.[illegible]

TEST ENGINEER [signature] 3-28-80

STUDY

TABLE 3.2.2-XV

RATE SENSOR TEST PROGRAM

DATE..3-28-80...... RUN..-X..R=24 in..

TEMP..72°F..50%RH.. SER#...381......

RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
-49.9179	.2651	.2945	.[illegible]43	-3.[illegible]
-99.8[illegible]66	.5848	.[illegible]33	.5[illegible]	-[illegible].997
-149.688	.8875	.919	.791	-2.641
-199.595	1.1999	1.2[illegible]	.9	-2.25[illegible]
-249.465	1.5494	1.5295	.974	-1.751
-299.3[illegible]	1.8165	1.838	.699	-1.1[illegible]
-349.255	2.1355	2.1471	.375	-.537
-399.164	2.4665	2.4559	-.149	.199
-449.[illegible]3	2.7943	2.7644	-.839	.933
-499.0[illegible]	3.1844	3.3731	-1.658	1.661
-449.116	2.7915	2.7651	-.951	.94[illegible]
-399.145	2.4683	2.4558	-.2[illegible]9	.961
-349.278	2.1385	2.1479	.991	-.433
-299.36	1.8199	1.8383	.597	-.99[illegible]
-249.5[illegible]	1.5469	1.5297	.76	-1.594
-199.695	1.1967	1.2229	.791	-1.957
-149.676	.8913	.9119	.667	-2.23
-99.8134	.5889	.6132	.4[illegible]	-2.4[illegible]
-49.[illegible]199	.2873	.2945	.915	-2.517
49.[illegible]61	-.3131	-.3231	-.395	-3.[illegible]
99.7399	-.614	-.6317	-.97	-2.5[illegible]
149.693	-.9179	-.9[illegible]4	-.749	-2.499
199.549	-1.2[illegible]	-1.2493	-.855	-2.149
249.4[illegible]7	-1.5395	-1.5589	-.931	-1.669
299.[illegible]	-1.8[illegible]	-1.8666	-.664	-1.1[illegible]
349.2[illegible]	-2.1646	-2.1759	-.365	-.59[illegible]
399.154	-2.4887	-2.4845	.133	.167
449.[illegible]73	-2.819	-2.7936	.797	.970
499.926	-3.1514	-3.1[illegible]1	1.599	1.595
449.9[illegible]	-2.8159	-2.7931	.857	.939
399.[illegible]19	-2.4934	-2.4939	.219	.969
349.265	-2.1669	-2.1759	-.29	-.415
299.337	-1.8484	-1.8669	-.592	-.9[illegible]
249.393	-1.5347	-1.5579	-.746	-1.49[illegible]
199.5[illegible]	-1.2253	-1.2492	-.774	-1.94
149.[illegible]7	-.9196	-.94[illegible]	-.934	-2.2[illegible]
99.7315	-.6163	-.6316	-.195	-2.4[illegible]
49.[illegible]740	-.315	-.3231	-.[illegible]	-2.[illegible]

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 5[illegible]

SCALE FACTOR (V/DEG/SEC): -6.[illegible]E-03

BIAS (VOLTS) : -1.4[illegible]E-[illegible]

HYSTERESIS, NEG RATES (VDC): -7.7[illegible]E-03

HYSTERESIS, POS RATES (VDC): 2.413[illegible]E-03

NULL OFFSET (VDC): -1.[illegible]E-[illegible]

TEST [illegible] [signature] 3-28-80

[illegible]

TABLE 3.2.2-XVI

DATE..3-28-80..... RUN..+Y R=24 in.

TEMP..72°F...50%RH.. SER#....381.....

RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% ERR	% IDEAL
-5[illegible].17[illegible]	.[illegible]8[illegible]	.2961	.3[illegible]	-3.197
-[illegible].71	.5[illegible]3	.[illegible]456	.[illegible]23	-3.117
-149.[illegible]3	.[illegible]853	.8147	.[illegible]8	-[illegible].737
-199.[illegible]68	1.1053	1.[illegible]838	.[illegible]88	-[illegible].3[illegible]
-[illegible]49.53[illegible]	1.5[illegible]5[illegible]	1.533	.[illegible]97	-1.79[illegible]
-899.433	1.8199	1.8423	.782	-1.[illegible]36
-349.34	2.1399	2.1517	.381	-.546
-399.155	2.4657	2.4635	-.167	.[illegible]39
-449.128	2.7967	2.7733	-.85	.946
-49[illegible].[illegible]48	3.1323	3.[illegible]798	-1.697	1.7
-449.13	2.7984	2.7733	-.984	1.027
-399.03	2.4683	2.461	-.[illegible]35	.295
-349.488	2.1436	2.1523	.[illegible]1	-.[illegible]38
-[illegible]99.477	1.[illegible]84	1.[illegible]486	.[illegible]6	-1.[illegible]38
-[illegible]49.53[illegible]	1.5[illegible]96	1.533	.7[illegible]4	-1.511
-199.[illegible]49	1.1997	1.[illegible]837	.774	-1.[illegible]4
-149.[illegible]	.[illegible]836	.8147	.[illegible]68	-[illegible].[illegible]75
-[illegible]9.[illegible]829	.5[illegible]97	.[illegible]853	.5[illegible]4	-[illegible].5[illegible]4
-5[illegible].[illegible]173	.[illegible]8[illegible]79	.[illegible]2961	.[illegible]264	-[illegible].[illegible]45
[illegible]9.7[illegible]4	-.3134	-.3[illegible]89	-.[illegible]94	-[illegible].[illegible]56
99.6976	-.6148	-.[illegible]638	-.[illegible]554	-[illegible].[illegible]778
149.[illegible]59	-.[illegible]9[illegible]5	-.[illegible]9[illegible]14	-.[illegible]73[illegible]	-[illegible].[illegible]467
19[illegible].435	-1.[illegible]8[illegible]4	-1.[illegible]8[illegible]3	-.[illegible]39	-[illegible].[illegible]4
[illegible]49.393	-1.5[illegible]45	-1.5[illegible]	-.[illegible]8	-1.[illegible]93
[illegible]99.1[illegible]	-1.[illegible]8[illegible]4	-1.[illegible]8[illegible]7	-.[illegible]55	-1.[illegible]1
349.1[illegible]6	-[illegible].1[illegible]75	-[illegible].1[illegible]83	-.34[illegible]	-.5
399.[illegible]78	-[illegible].4915	-[illegible].4[illegible]79	.117	.14[illegible]
448.9[illegible]	-[illegible].8[illegible]12	-[illegible].7871	.77[illegible]	.[illegible]6[illegible]
49[illegible].7[illegible]6	-3.1551	-3.1[illegible]61	1.59[illegible]	1.59[illegible]
448.833	-[illegible].8[illegible]83	-[illegible].787	.[illegible]15	.[illegible]4
398.978	-[illegible].453	-[illegible].4[illegible]73	.193	.[illegible]3
349.171	-[illegible].1[illegible]91	-[illegible].1[illegible]736	-.3[illegible]6	-.[illegible]5[illegible]
29[illegible].[illegible]55	-1.[illegible]85[illegible]1	-1.[illegible]8691	-.615	-1.[illegible]9
249.347	-1.5359	-1.5597	-.77	-1.545
199.[illegible]5[illegible]	-1.[illegible]8[illegible]61	-1.[illegible]25[illegible]4	-.7[illegible]4	-1.[illegible]3[illegible]
149.[illegible]84	-.[illegible]9[illegible]31	-.9413	-.[illegible]6[illegible]	-[illegible].[illegible]5
[illegible]9.7[illegible]61	-.6165	-.6[illegible]91	-.[illegible]23	-[illegible].[illegible]3
49.7975	-.3147	-.3[illegible]97	-.[illegible]56	-[illegible].573

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 5[illegible]

SCALE FACTOR (V/DEG/SEC): -[illegible].1[illegible]

BIAS (VOLTS) : -1.[illegible]

HYSTERESIS, NEG RATES (VDC): -4.[illegible]

HYSTERESIS, POS RATES (VDC): 1.[illegible]

FULL OFFSET (VDC): -1.[illegible]

TEST ENGINEER [signature] 3-28-80

[illegible]Y

TABLE 3.2.2-XVII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-28-80..... RUN..-Y...R=24 in..

TEMP..72°F...50%RH.. SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9926	.2874	.2958	.271	-2.795
	-99.8895	.5888	.6358	.548	-2.748
	-149.847	.8923	.9161	.768	-2.561
	-199.698	1.1986	1.2258	.876	-2.194
*	-249.564	1.5089	1.5358	.844	-1.698
	-299.419	1.8242	1.8458	.675	-1.128
	-349.321	2.1442	2.1558	.354	-.537
	-399.225	2.47	2.4658	-.154	.193
	-449.136	2.8009	2.7758	-.628	.921
	-498.993	3.1358	3.0849	-1.639	1.643
	-449.191	2.8317	2.7756	-.84	.935
	-399.24	2.4708	2.4653	-.178	.223
	-349.326	2.1458	2.1558	.338	-.435
	-299.461	1.826	1.8455	.626	-1.345
	-249.558	1.5115	1.5355	.774	-1.55
	-199.688	1.201	1.2257	.795	-1.991
	-149.768	.894	.9156	.696	-2.325
	-99.9386	.5901	.6361	.514	-2.57
	-53.3315	.288	.2959	.255	-2.548
	49.7818	-.3141	-.3039	-.316	-3.17
	99.6384	-.6159	-.6336	-.571	-2.866
	149.564	-.98	-.9438	-.768	-2.566
	199.457	-1.2866	-1.2537	-.967	-2.174
*	249.366	-1.5375	-1.5637	-.844	-1.698
	299.268	-1.8524	-1.8737	-.684	-1.143
	349.495	-2.1727	-2.1838	-.339	-.495
	399.319	-2.4978	-2.4933	.144	.18
	448.98	-2.8288	-2.8337	.839	.991
	498.931	-3.164	-3.1138	1.617	1.62
	448.936	-2.8338	-2.8334	.864	.962
	399.365	-2.4998	-2.4936	.8	.85
	349.837	-2.1748	-2.1838	-.295	-.422
	299.28	-1.8551	-1.8738	-.6	-1.338
	249.363	-1.5434	-1.5637	-.751	-1.526
	199.434	-1.2294	-1.2535	-.777	-1.947
	149.569	-.9224	-.9438	-.68	-2.336
	99.6089	-.6177	-.6334	-.537	-2.543
	49.7983	-.3152	-.324	-.285	-2.968

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.211776E-03

BIAS (VOLTS) : -1.470983E-02

HYSTERESIS, NEG RATES (VDC): -2.530034E-03

HYSTERESIS, POS RATES (VDC): 2.860078E-03

NULL OFFSET (VDC): -1.19394E-02

TEST ENGINEER Boyd W. Carey 3-28-80

READY

TABLE 3.2.2-XVIII

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 4-1-80 RUN +Z R=24.4 in.

TEMP 72°F 50%RH SER# 381

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.8313	-.016	-.0162	1.194	-11.992
	-99.61	-.0179	-.0182	1.639	-8.218
	-149.676	-.02	-.0202	.968	-3.213
	-199.629	-.022	-.0222	.849	-2.128
	-249.48	-.0238	-.0241	1.249	-2.524
	-299.492	-.0258	-.0261	1.499	-2.532
	-349.319	-.0278	-.0281	1.449	-2.374
	-399.175	-.0298	-.0301	1.534	-1.921
	-449.133	-.0318	-.0321	1.225	-1.364
	-499.335	-.0338	-.034	1.031	-1.033
	-449.327	-.0319	-.0321	1.016	-1.131
	-399.491	-.0299	-.0301	.688	-.874
	-349.263	-.028	-.0281	.534	-.764
	-299.426	-.0261	-.0261	.033	-.455
	-249.497	-.0242	-.0241	-.278	.559
	-199.609	-.0224	-.0222	-.99	2.481
	-149.742	-.0205	-.0202	-1.537	5.131
	-99.8252	-.0187	-.0182	-2.439	10.219
	-49.9164	-.0168	-.0162	-2.993	22.577
*	-.0046	-.013	-.0123	-3.693	-36.3498
	99.6841	-.011	-.0103	-3.792	-19.322
	149.687	-.009	-.0083	-3.417	-11.415
	199.581	-.0069	-.0063	-2.771	-6.942
	249.403	-.0048	-.0043	-2.283	-4.174
	299.358	-.0026	-.0024	-1.363	-2.277
	349.29	-.0004	-.0004	-.052	-.075
	399.156	.0018	.0016	1.259	1.577
	449.138	.0038	.0036	3.164	3.583
	498.967	.0065	.0055	4.865	4.875
	449.132	.0042	.0036	3.321	3.687
	399.282	.0019	.0016	1.632	2.348
	349.227	-.0002	-.0004	.833	1.19
	299.41	-.0024	-.0024	-.05	-.416
	249.452	-.0045	-.0043	-.769	-1.542
	199.552	-.0065	-.0063	-.637	-1.597
	149.667	-.0085	-.0083	-.946	-3.159
	99.7416	-.0105	-.0103	-1.272	-6.376
	49.8699	-.0124	-.0123	-.721	-7.227

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500
SCALE FACTOR (V/DEG/SEC): 3.966851E-05
BIAS (VOLTS) : -1.424358E-02
HYSTERESIS, NEG RATES (VDC): -8.999405E-09
HYSTERESIS, POS RATES (VDC): 0
NULL OFFSET (VDC): -1.361528E-02

TEST ENGINEER Boyd W. Cumpton 4-1-80

READY

TABLE 3.2.2-XIX

DATE..4-1-80..... RUN..4..R=24.4.1n.

TEMP..72°F..50%RH.. SER/....381.....

RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
-[illegible]	-.[illegible]	-.[illegible]	-.[illegible]	[illegible]
-[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-299.478	-.0246	-.0244	-1.[illegible]	1.[illegible]
-349.291	-.0261	-.0261	.447	-.[illegible]
-399.177	-.0275	-.0279	1.[illegible]	-[illegible]
-449.014	-.029	-.0296	3.675	-4.[illegible]
-498.[illegible]	-.[illegible]	-.[illegible]	[illegible]	[illegible]
-449.[illegible]	-.[illegible]	-.[illegible]	[illegible]	[illegible]
-398.87	-.0275	-.0279	1.[illegible]	-[illegible]
-349.[illegible]	-.0261	-.0261	.[illegible]	-.[illegible]
-299.[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]	1.[illegible]
-249.[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]	3.[illegible]
-199.[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-149.[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-99.[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
-49.[illegible]	-.[illegible]	-.[illegible]	-[illegible]	[illegible]
[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]	-[illegible]
99.[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]	-6.147
149.[illegible]	-.[illegible]	-.[illegible]	-.[illegible]	-.[illegible]
199.[illegible]	-.[illegible]	-.[illegible]	.[illegible]	.[illegible]
[illegible]	-.[illegible]	-.[illegible]	.[illegible]	[illegible]
[illegible]	-.[illegible]	-.[illegible]	[illegible]	[illegible]
349.[illegible]	-.[illegible]	-.[illegible]	1.[illegible]	2.[illegible]
399.[illegible]	.[illegible]	-.[illegible]	.[illegible]	[illegible]
[illegible]	.[illegible]	.[illegible]	[illegible]	[illegible]
[illegible]	.[illegible]	.[illegible]	1.[illegible]	[illegible]
[illegible]	.[illegible]	.[illegible]	1.[illegible]	[illegible]
449.[illegible]	.[illegible]	.[illegible]	1.[illegible]	1.[illegible]
399.[illegible]	.[illegible]	.[illegible]	1.[illegible]	1.[illegible]
349.[illegible]	-.[illegible]	-.[illegible]	1.[illegible]	1.[illegible]
[illegible]	.[illegible]	.[illegible]	.[illegible]	.[illegible]
[illegible]	-.[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]
[illegible]	-.[illegible]	-.[illegible]	-.[illegible]	-[illegible]
1[illegible]	-.[illegible]	-.[illegible]	-1.[illegible]	-[illegible]
[illegible]	-.[illegible]	-.[illegible]	-[illegible]	-11.[illegible]
[illegible]	-.[illegible]	-.[illegible]	-[illegible]	-[illegible]

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): [illegible]

SCALE FACTOR (V/DEG/SEC): 3.[illegible]

BIAS (VOLTS) : -.[illegible]

SYSTEMATIC, POS RATES (VDC): -[illegible]

SYSTEMATIC, POS RATES (VDC): [illegible]

CELL OFFSET (VDC): -[illegible]

TEST [illegible]

4-1-80

SUMMARY

TABLE 3.2.2-XX

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..4-1-80..... RUN..Z...R=0 in...

TEMP..72°F...50%RH.. SER#...381.....

RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
-50.0125	-.3151	-.3147	-3.691	36.1979
-99.8794	-.3163	-.3158	-3.836	19.745
-149.83	-.3173	-.3169	-3.99	13.96
-199.631	-.3183	-.318	-8.004	7.472
-249.687	-.3194	-.3191	-8.148	4.335
-299.563	-.3202	-.3202	-.239	.396
-349.436	-.321	-.3213	3.104	-4.442
-399.309	-.3219	-.3224	5.117	-6.456
-449.117	-.3225	-.3235	8.754	-9.746
-499.175	-.3232	-.3246	13.363	-13.396
-449.219	-.3225	-.3235	9.48	-13.136
-399.384	-.3219	-.3224	5.646	-7.47
-349.363	-.3211	-.3213	2.417	-3.459
-299.495	-.3203	-.3202	-.337	.569
-249.626	-.3193	-.3191	-1.979	3.963
-199.715	-.3185	-.318	-4.441	10.117
-149.667	-.3176	-.3169	-5.976	19.944
-99.8149	-.3166	-.3158	-7.938	36.0819
-50.0328	-.3156	-.3147	-7.963	78.685
49.865	-.3134	-.3125	-7.636	-76.5696
99.723	-.3122	-.3114	-6.9	-34.5965
149.781	-.311	-.3103	-5.595	-18.659
199.522	-.3097	-.3093	-4.362	-11.93
249.489	-.3083	-.3082	-1.747	-5.531
299.381	-.3071	-.3071	-.336	-.061
349.285	-.3057	-.306	2.414	4.414
399.198	-.3048	-.3049	5.831	7.333
449.107	-.3037	-.3038	9.386	14.449
498.965	-.3019	-.3027	13.979	13.3
449.133	-.3028	-.3038	9.07	14.49
399.156	-.3038	-.3049	6.175	7.735
349.295	-.3057	-.306	2.58	4.336
299.359	-.307	-.3071	.36	.631
249.484	-.3084	-.3082	-2.554	-5.116
199.557	-.3096	-.3093	-4.992	-10.332
149.687	-.311	-.3114	-5.749	-19.545
99.7772	-.3127	-.3114	-6.899	-34.5648
49.8619	-.3133	-.3125	-7.154	-71.2339

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): 2.19745E-35

BIAS (VOLTS) : -1.36332E-32

HYSTERESIS, NEG RATES (VDC): -5.91705E-35

HYSTERESIS, POS RATES (VDC): 1.87052E-35

NULL OFFSET (VDC): -1.35044E-32

TEST ENGINEER: 4-1-80

READY

TABLE 3.2.2-XXI

G - SENSITIVITY DATA
VOLTAGE OUTPUT (VOLTS)

AXIS ACCELER. X, Y, OR Z	RATE DEG/SEC	G	S/N 355				S/N 373				S/N 381			
			AT RADIUS		ZERO*		AT RADIUS		ZERO*		AT RADIUS		ZERO	
			CCW	CW	CCW	CW	CCW	CW	CCW	CW	CCW	CW	CCW	CW
+X	250	1.184	1.5327	-1.5279	1.5485	-1.5431	1.5418	-1.5465	1.5589	-1.5624	1.5087	-1.5379	1.5286	-1.5430
+X	500	4.736	3.1784	-3.165	3.2095	-3.194	3.2383	-3.2187	-	-	3.1366	-3.163	3.1669	-3.1748
NULL OFFSET MV**			+3.95		+2.73		-5.30		-5.55		-12.35		-7.85	
SCALE FACTOR MV/DEG/SEC			-6.24		-6.30		-6.32		-6.35		- 6.21		-6.28	
-X	250	1.184	1.5324	-1.5270	1.5485	-1.5431	1.5486	-1.5512	1.5589	-1.5624	1.5043	-1.5336	1.5286	-1.5430
-X	500	4.736	3.1748	-3.1606	3.2095	-3.1940	3.2494	3.2253	-	-	3.1244	-3.1514	3.1669	-3.1748
NULL OFFSET MV			+3.50		+2.73		-5.38		-5.55		-12.85		-7.85	
SCALE FACTOR MV/DEG/SEC			-6.24		-6.30		-6.34		-6.35		- 6.18		-6.28	
+Y	250	1.184	1.5266	-1.5216	1.5485	-1.5431	1.5493	-1.5508	1.5589	-1.5624	1.5074	-1.5352	1.5286	-1.5430
+Y	500	4.736	3.1643	-3.149	3.2095	-3.1940	3.2527	-3.2249	-	-	3.1323	-3.1551	3.1669	-3.1748
NULL OFFSET MV			3.52		2.73		-5.70		-5.55		-12.42		-7.85	
SCALE FACTOR MV/DEG/SEC			-6.22		-6.30		-6.35		-6.35		- 6.20		-6.28	
-Y	250	1.184	1.5274	-1.5236	1.5485	-1.5431	1.5403	-1.5490	1.5589	-1.5624	1.5102	-1.5389	1.5286	-1.5430
-Y	500	4.736	3.1626	-3.1554	3.2095	-3.1940	3.2322	-3.2228	-	-	3.1358	-3.1640	3.1669	-3.1748
NULL OFFSET MV			2.94		2.73		-6.61		-5.55		-11.99		-7.85	
SCALE FACTOR MV/DEG/SEC			-6.22		-6.30		-6.33		-6.35		- 6.21		-6.28	
+Z	250	1.1643	-.0056	+.0093	-.0002	+.0031	-.0297	+.0157	-.0255	+.0094	-.0241	-.0047	-.0194	-.0084
+Z	500	4.6571	-.0125	+.0184	-.0043	+.0060	-.0520	+.0325	-.0433	+.0185	-.0338	+.0065	-.0232	-.0012
NULL OFFSET MV			2.10		0.98		-6.20		-6.40		-13.60		-13.60	
SCALE FACTOR MV/DEG/SEC			-6.22		-6.30		-6.33		-6.35		6.21		6.28	
-Z	250	1.2037	-.0049	+.0081	-.0002	+.0031	-.0291	+.0147	-.0255	+.0094	-.0229	-.0052	-.0194	-.0084
-Z	500	4.8149	-.0099	+.0144	+.0043	+.0060	-.0493	+.0289	-.0433	+.0185	-.0302	+.0037	-.0232	-.0012
NULL OFFSET MV			2.20		0.98		-6.40		-6.40		-13.50		-13.60	
SCALE FACTOR MV/DEG/SEC			NA		NA		NA		NA		NA		NA	

*DATA OBTAINED FROM POST ACCEL TEST BASELINE TEST FOR +X, -X, +Y AND -Y AXES.
**MV IS MILLIVOLTS

TABLE 3.2.2-XXII

3.2.3 Data Evaluation

Using Table 3.2.2-XXII, the acceleration sensitivity of the "Superjet" was calculated for the "Maximum Performance Escape System" scenario

The G-sensitive terms were reduced as follows:

$$Gs = \frac{\frac{(V-NO)}{(SF)\text{At Radius}} - \frac{(V-NO)}{(SF)\text{Zero Arm}}}{G} \qquad \text{Eq (5)}$$

where:

Gs = Acceleration Sensitivity (deg/sec/g)
V = Voltage Output Counterclockwise or Clockwise
NO = Null Offset
SF = Scale Factor at Zero or at Radius (volts/deg/sec)
G = Acceleration Level in Units of Gravity g (where g = 32.17 ft/sec^2)

The G-sensitivity was calculated and is compared with the manufacturer's G-sensitivity data as shown in Table 3.2.3-I. The values obtained by Martin Marietta represent the worst case for each individual axis. The manufacturer's data was evaluated by accelerating the axes at 20.0g and positioning the rate sensor on a rate table to be rate insensitive. This was done on a 4.0 inch arm at 2500 degrees/second clockwise and counterclockwise. The G-sensitivity data was calculated as shown for rate insensitive orientations:

$$Gs = \frac{Vcw + Vccw}{2G(SF)} = \text{degrees/second/g} \qquad \text{Eq (6)}$$

where:

Gs = G-sensitivity
Vcw = Voltage Output Clockwise
Vccw = Voltage Output Counterclockwise
G = 20 g where g = 32.174 ft/sec^2
SF = Scale Factor (nominally 0.006 v/degrees/second)

G-SENSITIVITY COMPARISON

AXIS ACCELERATED	MMC		MANUFACTURER	
	DEG/SEC/G	G	DEG/SEC/G	G
X	1.33	1.184g	0.13	20g
Y	1.68	1.184g	0.14	20g
Z	0.90	1.164g	0.02	20g

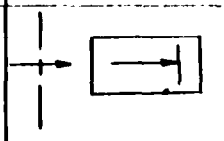
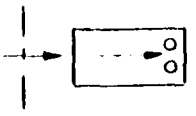
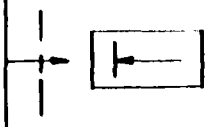
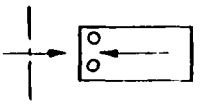
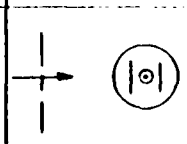
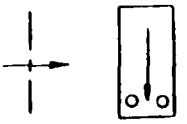
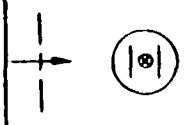
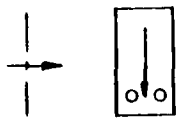
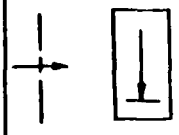
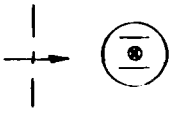
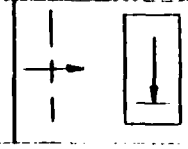
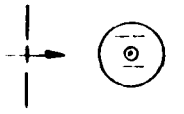
TABLE 3.2.3-I

It is questionable whether it is correct to calculate the G-sensitivity term by averaging the clockwise and counterclockwise rate outputs, without considering the rate outputs in the absence of acceleration, since these outputs are not necessarily equal to each other.

For tests that have the rate sensor input axis parallel to the rate table axis of rotation, the rate sensor would gradually go into saturation at rates above 500 deg/s so that the difference in output would strictly be a matter of difference in saturation and not necessarily due to linear acceleration

The G-sensitivity data for each direction and g level is shown in Table 3.2.3-II along with the manufacturers data. Included in the table are sketches showing sensor orientations with respect to the acceleration vector and centerline of the rate table. The sensor sketch shows the wires and jet axis orientation. The arrow inside the block is the jet axis.

G-SENSITIVITY = DEG/SEC/G

AXIS ACCELERATED	MMC		355	373	381	NOTE	HAMILTON STANDARD
+X		ccw	-0.311	-1.331	+0.235	1	 .13
		ccw	-0.060	-	+0.326	2	
		cw	+0.100	-1.108	+1.022	3	
		cw	+0.090	-	+0.646	4	
-X		ccw	-0.291	-1.067	+0.706	1	 .13
		ccw	-0.167	-	+0.446	2	
		cw	-0.082	-1.011	+1.373	3	
		cw	-0.074	-	+0.753	4	
+Y		ccw	-0.416	-1.257	+0.401	1	 .14
		ccw	-0.179	-	+0.355	2	
		cw	-0.147	-1.563	+0.979	3	
		cw	-0.123	-	+0.547	4	
-Y		ccw	-0.228	-1.683	+0.390	1	 .14
		ccw	-0.217	-	+0.286	2	
		cw	+0.046	-1.275	+1.206	3	
		cw	+0.075	-	+0.692	4	
+Z		ccw	+0.902	+0.605	+0.659	5	 .02
		ccw	+0.324	+0.306	+0.370	6	
		cw	+0.705	+0.834	+0.520	7	
		cw	+0.392	+0.471	+0.271	8	
-Z		ccw	+0.793	+0.408	+0.490	9	 .02
		ccw	+0.230	+0.201	+0.249	10	
		cw	+0.508	+0.702	+0.422	11	
		cw	+0.242	+0.344	+0.165	12	

Notes:

1) 250°/s, 1.184 g
2) 500°/s, 4.736 g
3) 250°/s, 1.184 g
4) 500°/s, 4.736 g
5) 250°/s, 1.1643 g
6) 500°/s, 4.657 g
7) 250°/s, 1.645 g
8) 500°/s, 4.657 g
9) 250°/s, 1.8037 g
10) 500°/s, 4.815 g
11) 250°/s, 1.2037 g
12) 500°/s, 4.8149 g

TABLE 3.2.3-11

3.3 High Temperature Sensitivity

3.3.1 Test Setup and Procedure

The test setup for the +165°F ±5°F temperature sensitivity environment is the same as the baseline test setup except for the addition of heat.

A thermistor was mounted under one of the rate sensor mounting screws. A portable environmental chamber was mounted over the 8"X8"X8" test cube on the Genisco 1100-2 rate table. The heating coils located on the test cube were then connected to a temperature controller located in the rate table controller test console. After temperature equalization and soaking for 45 minutes minimum, the tests were run.

The temperature was monitored and controlled continuously throughout the test. A test schematic is shown in Figure C.3-1 of Appendix A, Part C.

The procedure is outlined in Appendix A Part C of this report. There were no deviations from the test plan.

3.3.2 Test Results

The test results are presented in the same form as the baseline test. The scale factor test program results are shown in Tables 3.3.2-I through 3.3.2-X. Tables 3.3.2-XI through 3.3.2-XIII show the output drift characteristics at different rates. The null offset measurement was added to the printout to monitor variations from setup to setup and day to day. From Table 3.3.2-I, a plot was made to show typically the high temperature effect on the output vs. input. This is shown in Figure 3.3.2-1 for S/N 355 and can be compared to the baseline data at room temperature recorded in Figure 3.1.2-1.

Readytime, threshold, and resolution were measured in the same manner as the baseline test.

3.3.3 Data Evaluation

The high temperature (+165°F ±5°F) sensitivity data for the 3 Superjet rate sensors tested produce the following worst case evaluation:

1.	Full Scale Rate at ±2% Linearity Error	625 ± 75 deg/sec
2.	Scale Factor	.0062 ±.0002 V/deg/sec
3.	Bias	±3.24 deg/sec
4.	Hysteresis	±.25 deg/sec
5.	Threshold	<.1 deg/sec
6.	Resolution	<.1 deg/sec
7.	Readytime	.068 sec maximum
8.	Drift	+.36 deg/sec/min maximum

A breakdown of tests data for each serial number is shown in Tables 3.3.3-I and 3.3.3-II.

It is evident that the high temperature increases the full scale rate at ±2% linearity and null bias appreciably. This is due to the fact that the Superjet sensors tested are not temperature compensated above ±145°F. Readytime increased slightly but is well within the 0.100 second requirement.

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-12-80..... RUN..HOT.....

TEMP..165°F..... SER#..355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9545	.3022	.3111	.3	-3.336
	-99.6388	.5985	.6145	.526	-2.636
	-148.773	.8971	.9181	.691	-2.336
	-198.746	1.1981	1.222	.788	-1.973
	-249.642	1.5025	1.5255	.756	-1.514
	-299.618	1.8138	1.8293	.649	-1.316
	-349.51	2.1036	2.1328	.341	-.43
	-399.296	2.4413	2.4355	-.191	.239
*	-449.432	2.7649	2.7432	-.811	.908
	-499.245	3.0942	3.0433	-1.678	1.675
	-449.367	2.7658	2.74	-.848	.943
	-399.36	2.4421	2.4359	-.238	.253
	-349.587	2.1041	2.1332	.332	-.432
	-299.565	1.8113	1.829	.583	-.973
	-249.665	1.503	1.5256	.742	-1.486
	-199.751	1.1988	1.2221	.765	-1.916
	-149.759	.8977	.918	.67	-2.239
	-99.948	.5991	.6151	.525	-2.622
	-49.9888	.3022	.3113	.341	-3.336
	49.8938	-.2899	-.2958	-.194	-1.949
*	99.7569	-.5864	-.5993	-.426	-2.134
	149.664	-.8846	-.9028	-.597	-1.996
	199.574	-1.1849	-1.2063	-.705	-1.765
	249.559	-1.4805	-1.5103	-.716	-1.435
	299.495	-1.7956	-1.814	-.602	-1.336
	349.352	-2.1068	-2.1172	-.342	-.489
	399.251	-2.4226	-2.4206	.066	.083
	449.234	-2.744	-2.7246	.638	.711
	499.132	-3.0734	-3.028	1.393	1.395
	449.288	-2.7447	-2.7249	.652	.726
	399.246	-2.4234	-2.4206	.091	.114
	349.354	-2.1076	-2.1172	-.314	-.449
	299.444	-1.7963	-1.8137	-.57	-.952
	249.576	-1.4895	-1.5104	-.686	-1.374
	199.689	-1.1861	-1.207	-.688	-1.722
	149.738	-.8857	-.9033	-.579	-1.932
	99.8038	-.5876	-.5996	-.393	-1.969
	49.8648	-.2909	-.2959	-.165	-1.651

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.00122E-03

BIAS (VOLTS) : 7.32315E-03

HYSTERESIS, NEG RATES (VDC): -8.00176E-04

HYSTERESIS, POS RATES (VDC): 1.26636E-03

NULL OFFSET (VDC): 6.43398E-03

TEST ENGINEER..[signature]..... 3-12-80

READY

TABLE 3.3.2-I

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-12-80..... RUN....HOT.....

TEMP..164°F..... SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-54.0066	.2978	.3081	.311	-3.419
	-99.9217	.5903	.6094	.578	-3.18
*	-149.851	.8849	.9139	.782	-2.87
	-199.766	1.1819	1.2122	.913	-2.515
	-249.732	1.4821	1.5138	.955	-2.104
	-299.56	1.7869	1.8146	.835	-1.534
	-349.563	2.0953	2.1165	.637	-1.033
	-399.436	2.4091	2.4176	.256	-.353
	-449.468	2.7289	2.7196	-.28	.343
	-499.358	3.0543	3.0208	-1.009	1.111
	-549.314	3.38469	3.32245	-1.881	1.883
	-499.28	3.055	3.0203	-1.344	1.151
	-449.389	2.7308	2.7192	-.35	.428
	-399.451	2.4116	2.4177	.184	-.253
	-349.548	2.0975	2.1164	.569	-.895
	-299.573	1.789	1.8147	.775	-1.424
	-249.705	1.4848	1.5137	.87	-1.915
	-199.692	1.1844	1.2117	.824	-2.27
	-149.857	.8878	.9139	.697	-2.559
	-99.9284	.5926	.6095	.509	-2.824
	-50.0332	.2993	.3081	.265	-2.919
	49.8536	-.2859	-.2947	-.265	-2.999
	99.7772	-.5791	-.5961	-.512	-2.895
*	149.831	-.8739	-.8981	-.75	-2.679
	199.668	-1.1712	-1.1991	-.84	-2.315
	249.594	-1.4716	-1.5006	-.873	-1.925
	299.518	-1.7749	-1.802	-.816	-1.498
	349.532	-2.0829	-2.1039	-.632	-.994
	399.433	-2.3956	-2.405	-.283	-.389
	449.368	-2.7138	-2.7066	.217	.266
	499.227	-3.0373	-3.0076	.896	.988
	549.197	-3.36596	-3.3092	1.71	1.712
	499.193	-3.038	-3.0074	.924	1.212
	449.281	-2.715	-2.7061	.269	.329
	399.452	-2.3971	-2.4053	-.245	-.337
	349.466	-2.0848	-2.1035	-.564	-.888
	299.483	-1.777	-1.8017	-.746	-1.37
	249.608	-1.4737	-1.5006	-.813	-1.792
	199.637	-1.1735	-1.199	-.769	-2.113
	149.759	-.8763	-.8979	-.65	-2.387
	99.7399	-.5811	-.5959	-.445	-2.453
	49.9074	-.2874	-.2951	-.23	-2.535

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550

SCALE FACTOR (V/DEG/SEC): -6.03694E-03

BIAS (VOLTS) : 6.21719E-03

HYSTERESIS, NEG RATES (VDC): -2.66031E-03

HYSTERESIS, POS RATES (VDC): 2.38895E-03

NULL OFFSET (VDC): 6.42287E-03

TEST ENGINEER [signature] 3-12-80

TABLE 3.3.2-11

RATE SENSOR TEST PROGRAM

DATE...3-12-80..... RUN...HOT..... NADC 80081-60

TEMP...164°F..... SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.979	.301	.3139	.352	-4.222
	-99.9318	.5962	.6193	.63	-3.78
	-149.905	.8935	.9248	.852	-3.411
	-199.761	1.1923	1.2295	1.002	-3.009
	-249.671	1.4959	1.5346	1.058	-2.541
*	-299.582	1.8024	1.8397	1.018	-2.039
	-349.551	2.1141	2.1452	.848	-1.456
	-399.519	2.4305	2.4507	.549	-.825
	-449.387	2.7528	2.7555	.073	-.098
	-499.353	3.0807	3.0609	-.539	.647
	-549.27	3.41375	3.36614	-1.298	1.418
	-599.226	3.75133	3.67152	-2.176	2.179
	-549.275	3.41371	3.36617	-1.296	1.416
	-499.329	3.0809	3.0608	-.548	.658
	-449.445	2.7535	2.7559	.065	-.086
	-399.516	2.4314	2.4506	.525	-.788
	-349.56	2.115	2.1453	.826	-1.417
	-299.597	1.8033	1.8398	.995	-1.994
	-249.724	1.4966	1.535	1.046	-2.512
	-199.758	1.1936	1.2295	.979	-2.94
	-149.832	.8942	.9243	.821	-3.287
	-99.9048	.5971	.6191	.602	-3.614
	-50.0005	.3015	.3141	.344	-4.125
	49.8772	-.2882	-.2965	-.226	-2.714
	99.7399	-.5835	-.6013	-.485	-2.919
	149.718	-.8804	-.9068	-.72	-2.886
*	199.638	-1.1794	-1.212	-.888	-2.668
	249.552	-1.4817	-1.5171	-.966	-2.322
	299.52	-1.7872	-1.8225	-.964	-1.931
	349.468	-2.0971	-2.1279	-.839	-1.44
	399.285	-2.4114	-2.4324	-.572	-.36
	449.256	-2.7314	-2.7379	-.175	-.234
	499.165	-3.0566	-3.043	.372	.447
	549.182	-3.38697	-3.34867	1.044	1.141
	599.127	-3.72146	-3.65399	1.84	1.842
	549.18	-3.38781	-3.34866	1.068	1.166
	499.292	-3.0574	-3.0437	.373	.448
	449.332	-2.7324	-2.7383	-.163	-.217
	399.391	-2.4125	-2.4331	-.562	-.844
	349.545	-2.0981	-2.1283	-.823	-1.413
	299.51	-1.7885	-1.8225	-.926	-1.856
	249.599	-1.4833	-1.5174	-.931	-2.237
	199.687	-1.1811	-1.2123	-.85	-2.553
	149.786	-.8821	-.9072	-.686	-2.747
	99.767	-.5849	-.6015	-.451	-2.71
	49.8976	-.2894	-.2966	-.196	-2.361

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 600

SCALE FACTOR (V/DEG/SEC): -6.11297E-03

BIAS (VOLTS) : 8.41362E-03

HYSTERESIS, NEG RATES (VDC): -9.17435E-04

HYSTERESIS, POS RATES (VDC): 1.69754E-03

NULL OFFSET (VDC): 6.63767E-03

TABLE 3.3.2-III

TEST ENGINEER.....

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..165°F..... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.8987	.328	.338	.392	-3.142
	-99.8015	.6401	.6556	.612	-2.453
*	-149.734	.9549	.9735	.73	-1.949
	-199.575	1.2735	1.2908	.681	-1.365
	-249.431	1.5967	1.6082	.452	-.725
	-299.397	1.9253	1.9262	.037	-.049
	-349.253	2.2598	2.2436	-.635	.727
	-399.125	2.6	2.5611	-1.529	1.532
	-349.218	2.2604	2.2434	-.666	.763
	-299.326	1.9258	1.9258	0	0
	-249.456	1.5973	1.6083	.435	-.697
	-199.556	1.274	1.2907	.654	-1.31
	-149.759	.9557	.9737	.706	-1.885
	-99.81	.6407	.6557	.589	-2.36
	-49.9443	.3284	.3383	.387	-3.1
	49.8832	-.2935	-.2972	-.146	-1.169
*	99.7518	-.6048	-.6147	-.39	-1.563
	149.593	-.9186	-.932	-.525	-1.484
	199.557	-1.2348	-1.25	-.597	-1.197
	249.42	-1.5552	-1.5675	-.48	-.77
	299.275	-1.8799	-1.8848	-.193	-.258
	349.198	-2.2099	-2.2326	.886	.328
	398.967	-2.5455	-2.5194	1.023	1.026
	349.182	-2.2165	-2.2325	.312	.357
	299.271	-1.8837	-1.8848	-.161	-.215
	249.439	-1.5561	-1.5676	-.449	-.721
	199.574	-1.2359	-1.2501	-.561	-1.124
	149.672	-.9196	-.9325	-.505	-1.35
	99.7619	-.6059	-.6147	-.348	-1.395
	49.8748	-.2944	-.2972	-.11	-.88

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 400

SCALE FACTOR (V/DEG/SEC): -6.36587E-03

BIAS (VOLTS) : 2.03222E-02

HYSTERESIS, NEG RATES (VDC): -7.75695E-04

HYSTERESIS, POS RATES (VDC): 1.12939E-03

NULL OFFSET (VDC): 1.76674E-02

TEST ENGINEER [signature] 3-13-80

READY

TABLE 3.3.2-IV

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..+165°F..... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9442	.3267	.3424	.492	-4.922
	-99.7982	.638	.6624	.761	-3.813
	-149.678	.9523	.9825	.941	-3.142
*	-199.527	1.27	1.3024	1.008	-2.526
	-249.477	1.5926	1.6229	.944	-1.893
	-299.373	1.9226	1.9432	.704	-1.175
	-349.252	2.2545	2.2632	.272	-.389
	-399.145	2.5944	2.5834	-.343	.43
	-449.023	2.9395	2.9036	-1.12	1.247
	-498.967	3.28721	3.224	-1.967	1.971
	-449.02	2.9399	2.9035	-1.133	1.262
	-399.157	2.5952	2.5835	-.365	.458
	-349.263	2.256	2.2633	.228	-.326
	-299.27	1.922	1.9425	.637	-1.064
	-249.492	1.5942	1.623	.899	-1.822
	-199.517	1.2717	1.3023	.954	-2.39
	-149.738	.9538	.9827	.9	-3.005
	-99.8366	.6394	.6624	.719	-3.601
	-49.9281	.3276	.3423	.46	-4.633
	49.8846	-.2933	-.2962	-.154	-1.539
	99.6976	-.6139	-.6179	-.435	-2.182
	149.615	-.9169	-.9382	-.665	-2.823
	199.471	-1.2324	-1.2582	-.892	-2.011
*	249.431	-1.552	-1.5786	-.928	-1.661
	299.3	-1.876	-1.8988	-.713	-1.191
	349.266	-2.2055	-2.2195	-.437	-.626
	399.048	-2.54	-2.539	.034	.042
	448.979	-2.8831	-2.8594	.645	.717
	498.82	-3.2039	-3.1793	1.39	1.393
	448.93	-2.8848	-2.8591	.678	.755
	399.041	-2.5412	-2.5389	.37	.387
	349.143	-2.2367	-2.2187	-.375	-.538
	299.31	-1.8772	-1.8989	-.676	-1.129
	249.412	-1.5536	-1.5787	-.781	-1.567
	199.503	-1.2338	-1.2585	-.772	-1.933
	149.647	-.9182	-.9384	-.631	-2.138
	99.7585	-.6352	-.6183	-.436	-2.235
	49.864	-.294	-.2981	-.128	-1.285

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.41754E-03

BIAS (VOLTS) : 2.19196E-02

HYSTERESIS, NEG RATES (VDC): -.001683

HYSTERESIS, POS RATES (VDC): 1.56927E-03

NULL OFFSET (VDC): .016964

TEST ENGINEER: [signature] 3-13-80

READY

TABLE - 3.3.2-V

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..+165°F..... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.912	.3264	.3446	.513	-5.652
	-99.7998	.6377	.6664	.809	-4.457
	-149.632	.9523	.9879	1.303	-3.685
*	-199.566	1.2698	1.31	1.132	-3.121
	-249.422	1.5925	1.6316	1.131	-2.428
	-299.331	1.9285	1.9535	.93	-1.738
	-349.267	2.2545	2.2756	.594	-.935
	-399.116	2.5942	2.5972	.083	-.114
	-449.094	2.9392	2.9195	-.555	.679
	-498.956	3.28703	3.2412	-1.291	1.423
	-548.769	3.63494	3.56255	-2.34	2.345
	-498.84	3.28789	3.2404	-1.336	1.473
	-448.906	2.9403	2.9183	-.618	.757
	-399.115	2.5956	2.5972	.043	-.059
	-349.226	2.256	2.2753	.547	-.861
	-299.299	1.9219	1.9533	.886	-1.628
	-249.492	1.5942	1.632	1.067	-2.351
	-199.543	1.2715	1.3298	1.38	-2.978
	-149.649	.9536	.988	.97	-3.565
	-99.8252	.6391	.6666	.776	-4.273
	-49.9238	.3273	.3447	.49	-5.398
	49.8697	-.2932	-.299	-.163	-1.832
	99.7281	-.6041	-.6206	-.467	-2.576
	149.581	-.917	-.9422	-.711	-2.613
	199.466	-1.2327	-1.264	-.882	-2.432
	249.41	-1.5524	-1.5862	-.952	-2.399
	299.297	-1.8764	-1.938	-.889	-1.634
*	349.237	-2.2056	-2.2301	-.691	-1.389
	398.979	-2.5406	-2.5539	-.29	-.4
	449.221	-2.8809	-2.8737	.231	.246
	498.87	-3.2245	-3.1953	.823	.937
	548.775	-3.56964	-3.51716	1.479	1.482
	498.811	-3.2253	-3.1949	.856	.944
	448.95	-2.8816	-2.8733	.233	.286
	399.048	-2.542	-2.5514	-.265	-.366
	349.17	-2.2072	-2.2297	-.633	-.997
	299.285	-1.8777	-1.9079	-.851	-1.564
	249.436	-1.5539	-1.5861	-.91	-2.038
	199.532	-1.2343	-1.2644	-.849	-2.34
	149.581	-.9186	-.9422	-.665	-2.447
	99.6736	-.6054	-.6203	-.418	-2.339
	49.8513	-.2941	-.2989	-.136	-1.493

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550

SCALE FACTOR (V/DEG/SEC): -6.45053E-03

BIAS (VOLTS) : 2.265892E-02

HYSTERESIS, NEG RATES (VDC): -1.68777E-03

HYSTERESIS, POS RATES (VDC): 1.62792E-03

NULL OFFSET (VDC): 1.674477E-02

TABLE 3.3.2-VI TEST ENGINEER..... 3-13-80

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-12-80..... RUN....HOT.....

TEMP..165°F..... SER#....381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9822	.2801	.2883	.241	-2.647
	-99.9064	.5811	.5961	.441	-2.429
	-149.9	.8841	.9044	.599	-2.197
	-199.742	1.1887	1.2117	.68	-1.873
*	-249.732	1.4966	1.52	.69	-1.52
	-299.597	1.8078	1.8275	.581	-1.307
	-349.546	2.1225	2.1355	.382	-.632
	-399.516	2.4405	2.4436	.092	-.127
	-449.434	2.7614	2.7514	-.296	.362
	-499.363	3.0838	3.0593	-.722	.795
	-549.294	3.40551	3.36724	-1.128	1.13
	-499.292	3.0843	3.0589	-.751	.827
	-449.335	2.7623	2.7511	-.33	.404
	-399.419	2.4415	2.443	.045	-.062
	-349.535	2.1237	2.1352	.34	-.536
	-299.61	1.8088	1.8276	.552	-1.313
	-249.73	1.4979	1.52	.652	-1.436
	-199.793	1.1898	1.212	.656	-1.845
	-149.886	.8851	.9043	.566	-2.378
	-99.8827	.582	.596	.41	-2.26
	-50.0058	.2807	.2884	.228	-2.509
	49.9249	-.3208	-.3272	-.206	-2.272
*	99.7941	-.6021	-.6353	-.39	-2.15
	149.713	-.925	-.9431	-.536	-1.968
	199.672	-1.2299	-1.2512	-.628	-1.729
	249.626	-1.5374	-1.5591	-.64	-1.411
	299.459	-1.8478	-1.8665	-.553	-1.317
	349.398	-2.1615	-2.1745	-.382	-.632
	399.386	-2.4782	-2.4827	-.132	-.188
	449.39	-2.7981	-2.7911	.228	.255
	499.246	-3.1191	-3.0985	.607	.669
	549.224	-3.43956	-3.40662	.971	.973
	499.193	-3.1196	-3.0982	.633	.698
	449.236	-2.799	-2.7901	.261	.319
	399.307	-2.4794	-2.4822	-.084	-.115
	349.486	-2.1627	-2.175	-.363	-.572
	299.501	-1.849	-1.8668	-.525	-.964
	249.616	-1.5387	-1.5592	-.635	-1.333
	199.671	-1.2312	-1.2512	-.59	-1.626
	149.669	-.9263	-.9429	-.487	-1.79
	99.7602	-.6236	-.6351	-.339	-1.866
	49.8565	-.3223	-.3274	-.149	-1.646

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550

SCALE FACTOR (V/DEG/SEC): -6.16636E-03

BIAS (VOLTS) : -1.99573E-02

HYSTERESIS, NEG RATES (VDC): -1.27745E-03

HYSTERESIS, POS RATES (VDC): 1.54114E-03

NULL OFFSET (VDC): -1.96618E-02

TABLE 3.3.2-VII TEST ENGINEER: [signature] 3-12-80

RATE SENSOR TEST PROGRAM

DATE..3-12-80..... RUN.....HOT.....

TEMP..163°F..... SER#....381.....

NADC 80081-60

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-50	.2821	.2894	.251	-3.015
	-99.8845	.5807	.5978	.46	-2.765
	-149.798	.8834	.9063	.618	-2.475
	-199.752	1.1881	1.2151	.727	-2.183
	-249.697	1.4964	1.5238	.74	-1.779
	-299.566	1.8076	1.8321	.661	-1.324
	-349.583	2.122	2.1413	.519	-.891
*	-399.45	2.4397	2.4495	.263	-.396
	-449.389	2.7608	2.7582	-.07	.093
	-499.294	3.0835	3.0667	-.455	.546
	-549.255	3.40516	3.37555	-.798	.872
	-599.167	3.72361	3.68408	-1.066	1.067
	-549.363	3.40573	3.37622	-.796	.869
	-499.307	3.0841	3.0668	-.468	.562
	-449.411	2.7616	2.7583	-.088	.118
	-399.505	2.4408	2.4498	.243	-.365
	-349.594	2.123	2.1413	.494	-.848
	-299.602	1.8081	1.8323	.653	-1.308
	-249.702	1.4971	1.5238	.722	-1.735
	-199.79	1.1892	1.2153	.706	-2.119
	-149.788	.8843	.9062	.592	-2.372
	-99.8997	.5816	.5979	.437	-2.625
	-49.9899	.2835	.2893	.239	-2.868
	49.8533	-.3208	-.3278	-.189	-2.272
*	99.7957	-.6218	-.6365	-.398	-2.394
	149.738	-.9245	-.9452	-.558	-2.237
	199.579	-1.2294	-1.2533	-.646	-1.942
	249.596	-1.5369	-1.5625	-.691	-1.661
	299.542	-1.847	-1.8712	-.654	-1.31
	349.459	-2.1607	-2.1798	-.516	-.886
	399.334	-2.4777	-2.4681	-.279	-.419
	449.26	-2.7973	-2.7967	.317	.323
	499.221	-3.1183	-3.1055	.343	.413
	549.173	-3.43881	-3.41426	.662	.723
	599.127	-3.75621	-3.72305	.894	.895
	549.212	-3.43951	-3.4145	.674	.737
	499.286	-3.1191	-3.1059	.354	.425
	449.42	-2.7981	-2.7977	.011	.015
	399.396	-2.4786	-2.4385	-.265	-.398
	349.479	-2.1621	-2.1799	-.481	-.826
	299.476	-1.8483	-1.8708	-.608	-1.218
	249.574	-1.5382	-1.5624	-.653	-1.569
	199.645	-1.2309	-1.2537	-.616	-1.851
	149.649	-.9264	-.9447	-.493	-1.977
	99.7484	-.6237	-.6362	-.338	-2.033
	49.8944	-.3223	-.3281	-.155	-1.859

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 600

SCALE FACTOR (V/DEG/SEC): -6.18139E-03

BIAS (VOLTS) : -1.96605E-02

HYSTERESIS, NEG RATES (VDC): -1.10579E-03

HYSTERESIS, POS RATES (VDC): 1.93787E-03

NULL OFFSET (VDC): -1.93361E-02

TABLE 3.3.2-VIII

TEST ENGINEER..... 3-12-80

RATE SENSOR TEST PROGRAM

DATE..3-12-80..... RUN...HOT.....

TEMP...164°F..... SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9743	.2793	.2895	.252	-3.272
	-99.9149	.5802	.5989	.465	-3.024
	-149.788	.883	.9078	.617	-2.679
	-199.758	1.1875	1.2174	.744	-2.421
	-249.675	1.4953	1.5267	.78	-2.031
*	-299.619	1.8061	1.8361	.744	-1.613
	-349.522	2.121	2.1452	.602	-1.12
	-399.482	2.4393	2.4547	.384	-.625
	-449.482	2.7603	2.7645	.103	-.15
	-499.326	3.0826	3.0733	-.232	.382
	-549.319	3.40475	3.38307	-.538	.637
	-599.096	3.72346	3.69145	-.795	.863
	-649.15	4.03508	4.03154	-.833	.834
	-599.208	3.72403	3.69214	-.792	.859
	-549.257	3.40568	3.38269	-.571	.676
	-499.368	3.0839	3.0736	-.257	.335
	-449.423	2.7614	2.7641	.068	-.098
	-399.466	2.4407	2.4547	.347	-.564
	-349.514	2.1225	2.1452	.564	-1.05
	-299.592	1.8078	1.8359	.699	-1.517
	-249.724	1.4968	1.527	.75	-1.952
	-199.725	1.1889	1.2172	.703	-2.289
	-149.915	.8842	.9086	.606	-2.629
	-99.9166	.5812	.5989	.438	-2.852
	-50.3181	.2799	.2897	.244	-3.171
	49.8755	-.3214	-.3291	-.192	-2.507
	99.8025	-.6224	-.6384	-.398	-2.595
	149.659	-.9254	-.9473	-.545	-2.366
	199.687	-1.23	-1.2572	-.677	-2.204
	249.571	-1.5374	-1.5663	-.717	-1.866
*	299.515	-1.8475	-1.8757	-.701	-1.521
	349.429	-2.1614	-2.1849	-.584	-1.387
	399.464	-2.4782	-2.4949	-.414	-.673
	449.356	-2.7979	-2.804	-.15	-.217
	499.253	-3.1192	-3.1131	.151	.197
	549.122	-3.44318	-3.422	.452	.534
	599.139	-3.75765	-3.73186	.64	.695
	648.975	-4.06943	-4.04061	.706	.707
	599.104	-3.75061	-3.73164	.67	.727
	549.239	-3.44103	-3.42253	.464	.549
	499.3	-3.1236	-3.1134	.18	.234
	449.336	-2.7997	-2.8038	-.104	-.15
	399.342	-2.48	-2.4941	-.351	-.571
	349.463	-2.1632	-2.1851	-.544	-1.011
	299.547	-1.8494	-1.8759	-.657	-1.427
	249.574	-1.5393	-1.5663	-.67	-1.744
	199.62	-1.2318	-1.2568	-.62	-2.018
	149.797	-.9272	-.9481	-.52	-2.258
	99.8448	-.6243	-.6387	-.357	-2.324
	49.8912	-.3229	-.3292	-.156	-2.037

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 650

SCALE FACTOR (V/DEG/SEC): -6.19521E-03

BIAS (VOLTS) : -2.31262E-02

HYSTERESIS, NEG RATES (VDC): -1.62228E-03

HYSTERESIS, POS RATES (VDC): 1.94048E-03

NULL OFFSET (VDC): -1.93639E-02

TEST ENGINEER.....

3-17-80

TABLE 3.3.2-IX

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-12-80..... RUN....HOT.....

TEMP..164°F..... SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-99.8895	.5798	.6019	.511	-3.578
	-199.749	1.1866	1.2193	.756	-2.65
	-299.575	1.8042	1.8364	.744	-1.739
*	-399.538	2.4364	2.4542	.413	-.723
	-499.26	3.0795	3.071	-.198	.277
	-599.192	3.72075	3.68884	-.737	.861
	-699.069	4.3338	4.30632	-.635	.636
	-599.148	3.72154	3.68857	-.762	.39
	-499.351	3.0807	3.0715	-.213	.298
	-399.46	2.4377	2.454	.377	-.66
	-299.578	1.8055	1.8365	.716	-1.674
	-199.756	1.1872	1.2193	.743	-2.683
	-99.8828	.5804	.6019	.496	-3.476
	99.8845	-.6205	-.6328	-.284	-1.99
	199.636	-1.2268	-1.2499	-.533	-1.87
	299.527	-1.8432	-1.8674	-.561	-1.31
*	399.363	-2.4726	-2.4846	-.278	-.487
	499.19	-3.113	-3.1018	.259	.363
	599.05	-3.75153	-3.71914	.749	.875
	698.951	-4.28764	-4.33677	-1.135	-1.137
	599.109	-3.75269	-3.7195	.767	.896
	499.188	-3.1145	-3.1018	.294	.412
	399.314	-2.4744	-2.4843	-.289	-.402
	299.537	-1.8448	-1.8675	-.524	-1.224
	199.61	-1.2284	-1.2497	-.493	-1.723
	99.8848	-.6222	-.6327	-.243	-1.783

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 700

SCALE FACTOR (V/DEG/SEC): -6.18237E-03

BIAS (VOLTS) : -.015642

HYSTERESIS, NEG RATES (VDC): -1.28984E-03

HYSTERESIS, POS RATES (VDC): 1.80912E-03

NULL OFFSET (VDC): -1.95895E-02

TEST ENGINEER: [signature] 3-12-80

READY

TABLE 3.3.2-X

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..+165°F..... SER#...355.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8386	.596905	5.97870E-03
99.8168	.597292	5.98389E-03
99.7797	.597534	5.98853E-03
99.7493	.597599	5.99131E-03
199.541	1.19771	6.00235E-03
199.556	1.19799	6.00327E-03
199.564	1.1983	6.00460E-03
199.544	1.19875	6.00745E-03
299.334	1.81288	6.05639E-03
299.308	1.81301	6.05735E-03
299.35	1.81355	6.05829E-03
299.33	1.81406	6.06039E-03
399.111	2.44711	6.13140E-03
399.078	2.44846	6.13529E-03
399.067	2.44944	6.13791E-03
399.109	2.44974	6.13802E-03
498.896	3.1049	6.22354E-03
498.799	3.10592	6.22679E-03
498.957	3.10605	6.22508E-03
498.854	3.10636	6.22698E-03

NULL OFFSET (VDC): 4.85412E-03

READY

3-13-80

TABLE 3.3.2-XI

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..163°F..... SER#...373.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8172	.63623	6.37395E-03
99.7848	.636856	6.38229E-03
99.7756	.636906	6.38338E-03
99.7782	.637096	6.38512E-03
199.542	1.26872	6.35817E-03
199.581	1.26943	6.36047E-03
199.563	1.27043	6.36606E-03
199.57	1.27093	6.36837E-03
299.293	1.92227	6.42268E-03
299.339	1.92247	6.42238E-03
299.34	1.92299	6.42412E-03
299.297	1.92375	6.42754E-03
399.106	2.59895	6.51194E-03
399.094	2.59987	6.51444E-03
399.091	2.60049	6.51632E-03
399.107	2.60119	6.51752E-03
498.849	3.29585	6.60690E-03
498.919	3.29692	6.60812E-03
498.848	3.29744	6.61313E-03
498.938	3.29846	6.61396E-03

NULL OFFSET (VDC): 1.63632E-03

READY

3-13-80

TABLE 3.3.2-XII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE..3-13-80..... RUN....HOT.....

TEMP..165°F..... SER#...381.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.9279	.57377	5.74184E-03
99.9183	.574024	5.74493E-03
99.9609	.574516	5.74740E-03
99.935	.574479	5.74853E-03
199.76	1.17852	5.89967E-03
199.757	1.17897	5.90201E-03
199.758	1.17893	5.90178E-03
199.752	1.17928	5.90372E-03
299.574	1.79536	5.99303E-03
299.534	1.7955	5.99431E-03
299.534	1.79605	5.99614E-03
299.628	1.79699	5.99740E-03
399.391	2.4287	.006081
399.39	2.4289	6.08152E-03
399.433	2.42895	.006081
399.412	2.42972	6.08324E-03
499.185	3.07446	6.15895E-03
499.263	3.07449	6.15836E-03
499.302	3.07462	6.15782E-03
499.212	3.0749	6.15951E-03

NULL OFFSET (VDC): -.022159

READY

Boyd W. Cary Jr
3-13-80

TABLE 3.3.2-XIII

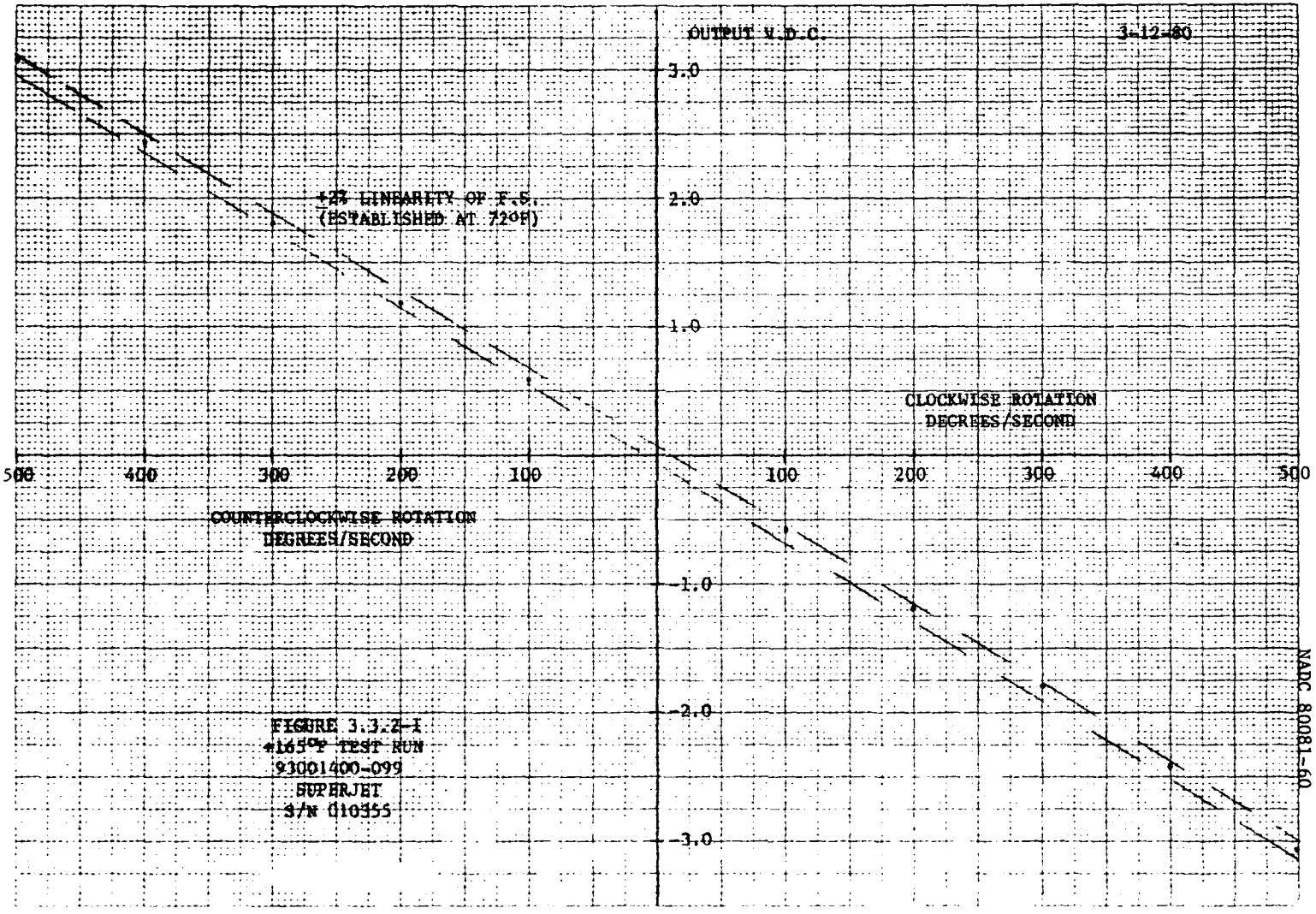


FIGURE 3.3.2-1
+165°F TEST RUN
93001400-099
SUPERJET
S/N 010355

HIGH TEMPERATURE TEST DATA SUMMARY
(+165°F ±5°F)

PARAMETER	S/N 355	S/N 373	S/N 381
FULL SCALE RATE (DEG/SECOND) AT ±2% LINEARITY ERROR	550	500	700
SCALE FACTOR (MV/DEG/SEC) AT BASELINE FACTOR	-6.08	-6.37	-6.17
BIAS (DEG/SECOND)	-1.20	-3.19	+3.24
HYSTERESIS CCW (DEG/SECOND)	+.15	+.12	+.21
HYSTERESIS CW (DEG/SECOND)	-.21	-.18	-.25
NULL OFFSET (DEG/SECOND)	-1.05	-2.77	+3.19
THRESHOLD (DEG/SECOND)	<.10	<.10	<.10
RESOLUTION (DEG/SECOND)	<.10	<.10	<.10
READYTIME (SECONDS) AVG. OF 5 RATES*	.059	.065	.068
DRIFT (DEG/SEC/MIN) AVG. OF 5 RATES*	.14	.14	.08

*100, 200, 300, 400, AND 500 DEGREES/SECOND
(See Table 3.3.3-II)

TABLE 3.3.3-I

HIGH TEMPERATURE DRIFT AND READYTIME SUMMARY
(+165°F ±5°F)

RATE (DEG/SEC)	OUTPUT DRIFT (DEG/SEC/MIN)			READYTIME (SECONDS)		
	355	373	381	355	373	381
100	+.27	+.23	+.14	.068	.065	.065
200	+.11	+.21	+.08	.052	.062	.067
300	+.09	+.10	+.09	.062	.062	.075
400	+.15	+.12	+.05	.060	.068	.060
500	+.08	+.08	+.01	.052	.070	.075

TABLE 3.3.3-II

3.4 Low Temperature Sensitivity

3.4.1 Test Setup and Procedure

The test setup for the -30°F ±5°F temperature sensitivity environment is the same as the baseline test setup except for the addition of cooling.

A thermocouple was mounted under one of the rate sensor mounting screws. A portable environmental chamber was mounted over the 8"X8"X8" test cube on the Genisco 1100-2 rate table.

A tank of liquid nitrogen was used for cooling by pressurizing with dry nitrogen. The dry nitrogen pressure was controlled by a solenoid to maintain a constant temperature. After temperature stabilization and a 45 minute soak, the test was run. The thermocouple was disconnected prior to each run. This was done due to the absence of thermocouple wiring in the rate table slip rings.

This test deviates from the -65°F ±5°F described in the test plan. This was discussed and approved by NADC at the mid-task review.

A test schematic is shown in Figure C.3-2 of Appendix A, Part C.

3.4.2 Test Results

The test results are presented in the same manner as the baseline test. The results are shown in tables 3.4.2-I through 3.4.2-IX. From table 3.4.2-II, a plot was made to typically show the low temperature effect on the output of the units. This is compared to the baseline data obtained at room temperature as shown in Figure 3.1.2-1. This particular plot is for S/N 355 sensor at 500 degrees/second maximum rate.

Readytime, threshold and resolution were measured exactly as done during the baseline test.

3.4.3 Data Evaluation

The cold temperature (-30°F ±5°F) sensitivity data for the Superjet rate sensors tested produced the following worst case evaluation:

1.	Full Scale Rate at ±2% Linearity Error	425 ±25 deg/sec
2.	Scale Factor	.0058 ± .0001 V/deg/sec
3.	Bias	±1.66 deg/sec
4.	Hysteresis	±2.44 deg/sec
5.	Threshold	<0.1 deg/sec
6.	Resolution	<0.1 deg/sec
7.	Readytime	.069 sec max.
8.	Drift	random (±4.8 deg/sec/min)

The data recorded for each serial number is shown in Tables 3.4.3-I and 3.4.3-II.

The full scale rate decreases with cold temperature along with a scale factor reduction of approximately 10%. The hysteresis error increased substantially on serial number 355 while the other two units hardly changed.

Threshold, resolution and readytime were virtually unchanged while the drift characteristics were random. This may have been caused by the heating and cooling of the wires located in the sensor.

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE...3-17-80..... RUN...COLD.....

TEMP...-30°F..... SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9135	.2867	.2933	.26	-2.343
	-99.7846	.5624	.5737	.447	-2.315
	-149.663	.8369	.8541	.679	-2.341
	-199.5	1.1128	1.1342	.847	-1.909
	-249.409	1.3956	1.4148	.76	-1.371
	-299.367	1.6811	1.6957	.574	-.863
*	-349.159	1.9732	1.9756	.396	-.123
	-398.971	2.2808	2.2556	-.997	1.125
	-448.864	2.5903	2.5361	-2.144	2.15
	-399.04	2.2758	2.256	-.784	.884
	-349.155	1.9836	1.9756	-.316	.408
	-299.286	1.6876	1.6952	.301	-.453
	-249.404	1.3958	1.4148	.748	-1.35
	-199.489	1.1129	1.1342	.841	-1.887
	-149.688	.8301	.8538	.939	-2.824
	-99.7812	.5518	.5736	.863	-3.891
	-49.9168	.2754	.2933	.706	-6.365
*	49.8251	-.2632	-.2674	-.284	-2.566
	99.7632	-.5326	-.5481	-.615	-2.772
	149.601	-.8098	-.8283	-.732	-2.231
	199.427	-1.3917	-1.1084	-.664	-1.498
	249.352	-1.3747	-1.3891	-.571	-1.031
	299.246	-1.6601	-1.6696	-.375	-.563
	349.114	-1.9503	-1.95	.014	.318
	398.875	-2.242	-2.2297	.485	.547
	448.811	-2.5414	-2.5104	1.226	1.229
	398.931	-2.2374	-2.23	.293	.33
	349.148	-1.942	-1.9501	-.323	-.416
	299.166	-1.6535	-1.6692	-.62	-.932
	249.395	-1.3739	-1.3894	-.612	-1.104
	199.44	-1.095	-1.1085	-.535	-1.236
	149.643	-.816	-.8086	-.498	-1.496
	99.7721	-.5405	-.5482	-.303	-1.368
	49.8652	-.2751	-.2676	.295	2.664

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450

SCALE FACTOR (V/DEG/SEC): -5.62178E-03

BIAS (VOLTS) : 1.26843E-02

HYSTERESIS, NEG RATES (VDC): -1.04051E-02

HYSTERESIS, POS RATES (VDC): 1.48815E-02

NULL OFFSET (VDC): 1.73858E-03

TEST ENGINEER [signature] 3-17-80

READY

TABLE 3.4.2-I

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-17-80..... RUN...COLD.....

TEMP..-30°F..... SER#..355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9178	.2763	.2822	.556	-5.57
	-99.8134	.552	.5768	.867	-4.345
	-149.69	.8387	.8618	1.373	-3.563
	-199.563	1.1186	1.1457	1.161	-2.5[illegible]
	-249.443	1.3985	1.4332	1.375	-2.155
	-299.285	1.6917	1.7141	.759	-1.31[illegible]
	-349.194	1.9875	1.9992	.41	-.587
	-399.435	2.2886	2.2834	-.217	.[illegible]79
*	-448.888	2.5931	2.5678	-.889	.9[illegible]
	-498.822	2.8925	2.8526	-2.451	2.45[illegible]6
	-449.[illegible]06	2.606	2.5685	-1.316	1.465
	-399.[illegible]83	2.2918	2.2834	-.295	.369
	-349.1[illegible]6	1.9842	1.9991	.505	-.751
	-299.315	1.6916	1.7147	.839	-1.351
	-249.355	1.4375	1.4287	.777	-1.553
	-199.46	1.123	1.1452	.79	-1.[illegible]56
	-149.648	.8417	.861	.675	-2.057
	-99.7457	.5688	.5764	.476	-2.387
	-49.9396	.2777	.2923	.513	-5.13[illegible]
	49.8655	-.273	-.277	-.132	-1.3[illegible]4
	99.7213	-.5483	-.5613	-.457	-2.291
	149.633	-.836	-.846	-.7	-2.341
	199.52	-1.1257	-1.1345	-.672	-2.1[illegible]6
	249.366	-1.388[illegible]	-1.4148	-.941	-1.[illegible]77
	299.215	-1.6741	-1.6992	-.878	-1.467
	349.[illegible]99	-1.9679	-1.9837	-.553	-.791
*	398.9[illegible]8	-2.2636	-2.2678	-.146	-.1[illegible]3
	448.923	-2.5686	-2.5531	.546	.6[illegible]5
	498.762[illegible]	-2.8822	-2.8373	1.575	1.579
	448.836	-2.58[illegible]	-2.5526	.963	1.[illegible]73
	398.[illegible]16	-2.2775	-2.2664	.319	.4
	349.119	-1.9756	-1.9838	-.289	-.413
	299.183	-1.6799	-1.699	-.67	-1.1[illegible]
	249.445	-1.3911	-1.4151	-.839	-1.6[illegible]2
	199.[illegible]25	-1.1[illegible]07	-1.13	-.[illegible]38	-2.[illegible]26
	149.535	-.8873	-.8454	-.637	-2.1[illegible]8
	99.7365	-.5516	-.5614	-.343	-1.7[illegible]2
	49.8626	-.2641	-.2769	-.451	-4.525

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 5[illegible]

SCALE FACTOR (V/DEG/SEC): -5.733[illegible]3E-[illegible]3

BIAS (VOLTS) : 7.455[illegible]9E-[illegible]3

HYSTERESIS, NEG RATES (VDC): -1.[illegible]8[illegible]93E-[illegible]2

HYSTERESIS, POS RATES (VDC): 1.[illegible]9[illegible]9E-[illegible]2

NULL OFFSET (VDC): 2.47[illegible]25E-[illegible]3

TEST ENGINEER.....

3-17-80

READY

TABLE 3.4.2-II

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-14-80..... RUN...COLD.....

TEMP...-30°F..... SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9432	.292	.3045	.529	-4.238
	-99.8069	.5839	.5988	.631	-2.526
	-149.632	.8781	.8926	.615	-1.645
	-199.511	1.1729	1.1869	.591	-1.184
	-249.419	1.4722	1.4813	.384	-.615
	-299.326	1.7752	1.7757	.024	-.033
	-349.182	2.0884	2.0699	-.788	.902
	-399.035	2.4095	2.3638	-1.938	1.943
	-349.116	2.0874	2.0695	-.761	.872
	-299.291	1.7745	1.7755	.045	-.36
	-249.468	1.4677	1.4816	.586	-.94
	-199.536	1.1695	1.187	.741	-1.486
	-149.676	.8746	.8929	.775	-2.07
	-99.8134	.5813	.5987	.738	-2.959
	-49.9442	.2892	.3045	.646	-5.176
*	49.834	-.2864	-.2842	.096	.767
	99.7129	-.5744	-.5784	-.171	-.687
	149.53	-.8657	-.8723	-.281	-.753
	199.449	-1.1584	-1.1668	-.356	-.713
	249.278	-1.4534	-1.4608	-.315	-.505
	299.224	-1.7511	-1.7555	-.186	-.249
	348.994	-2.0549	-2.0491	.245	.281
	398.995	-2.3667	-2.3441	.956	.959
	349.122	-2.0525	-2.0497	.116	.132
	299.163	-1.7435	-1.7551	-.492	-.657
	249.324	-1.4421	-1.4611	-.804	-1.29
	199.489	-1.1469	-1.1671	-.857	-1.718
	149.53	-.8584	-.8723	-.592	-1.584
	99.7298	-.5718	-.5785	-.285	-1.143
	49.8531	-.2868	-.2843	.107	.859

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 400

SCALE FACTOR (V/DEG/SEC): -5.89959E-03

BIAS (VOLTS) : 9.82109E-03

HYSTERESIS, NEG RATES (VDC): -9.99900E-09

HYSTERESIS, POS RATES (VDC): 3.84152E-04

NULL OFFSET (VDC): 1.11750E-03

TEST ENGINEER.....

3-14-80

READY

TABLE 3.4.2-III

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-14-80..... RUN..COLD.....

TEMP...-28°F..... SER#.373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
*	-49.9183	.2668	.2808	.55	-4.958
	-99.8337	.5394	.5625	.908	-4.383
	-149.743	.8145	.8439	1.159	-3.482
	-199.478	1.0964	1.1248	1.121	-2.522
	-249.438	1.3824	1.4066	.959	-1.731
	-299.313	1.6735	1.6883	.58	-.871
	-349.136	1.9731	1.9694	-.146	.188
	-398.998	2.278	2.2539	-1.072	1.239
	-448.917	2.5886	2.5385	-2.207	2.212
	-399.01	2.2754	2.2509	-.965	1.088
	-349.179	1.9721	1.9697	-.096	.124
	-299.382	1.6764	1.6886	.481	-.782
	-249.417	1.3884	1.4067	.718	-1.295
	-199.553	1.1042	1.1252	.827	-1.865
	-149.719	.8229	.844	.83	-2.494
	-99.7982	.5458	.5623	.648	-2.921
	-49.934	.27	.2809	.429	-3.868
*	48.8157	-.2742	-.2821	-.309	-2.795
	99.6892	-.5471	-.5635	-.645	-2.91
	149.542	-.8242	-.8449	-.814	-2.45
	199.342	-1.103	-1.1259	-.943	-2.339
	249.2[illegible]	-1.3863	-1.4077	-.845	-1.525
	299.131	-1.6752	-1.6891	-.545	-.82
	348.987	-1.9715	-1.9704	.041	.053
	398.88[illegible]	-2.[illegible]714	-2.252	.763	.861
	448.791	-2.5755	-2.5337	1.647	1.651
	398.872	-2.2641	-2.2519	.477	.538
	348.994	-1.9655	-1.9705	-.195	-.251
	299.138	-1.6739	-1.6891	-.6	-.903
	249.347	-1.3873	-1.4079	-.812	-1.466
	199.358	-1.1059	-1.126	-.799	-1.787
	149.603	-.8281	-.8452	-.672	-2.301
	99.7399	-.5532	-.5638	-.418	-1.885
	49.8384	-.2796	-.2822	-.142	-.918

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450

SCALE FACTOR (V/DEG/SEC): -5.64346E-03

BIAS (VOLTS) : -9.26246E-04

HYSTERESIS, NEG RATES (VDC): -8.43811E-03

HYSTERESIS, POS RATES (VDC): 6.04451E-03

NULL OFFSET (VDC): -5.69418E-03

TEST ENGINEER [signature] 3-14-80

READY

TABLE 3.4.2-IV

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-17-80..... RUN...COLD.....

TEMP..-30°F..... SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.8873	.272	.2812	.364	-3.881
	-99.7795	.5467	.5622	.61	-2.749
	-149.631	.8285	.843	.837	-2.427
	-199.563	1.1035	1.1242	.816	-1.841
	-249.426	1.3861	1.405	.749	-1.351
*	-299.349	1.6736	1.686	.546	-.761
	-349.12	1.969	1.9665	-.095	.122
	-398.959	2.2698	2.2473	-.888	1.002
	-448.891	2.5723	2.5285	-1.729	1.734
	-399.315	2.266	2.2476	-.728	.821
	-349.231	1.9681	1.967	-.042	.054
	-299.872	1.6761	1.6858	.381	-.573
	-249.436	1.389	1.4049	.629	-1.135
	-199.477	1.1347	1.1237	.748	-1.688
	-149.663	.8049	.8431	.722	-2.17
	-99.7745	.5496	.5622	.496	-2.235
	-49.9227	.2737	.2814	.331	-2.714
*	49.855	-.2763	-.2836	-.17	-1.536
	99.6384	-.5526	-.561	-.333	-1.502
	149.65	-.8288	-.8427	-.55	-1.653
	199.478	-1.1363	-1.1233	-.67	-1.512
	249.368	-1.3889	-1.4043	-.569	-1.327
	299.254	-1.6776	-1.6853	-.344	-.457
	349.111	-1.9682	-1.9661	.121	.135
	399.343	-2.2646	-2.2473	.68	.766
	448.845	-2.569	-2.5279	1.466	1.468
	398.999	-2.258	-2.2471	.432	.427
	349.171	-1.9588	-1.9665	-.3	-.387
	299.056	-1.6664	-1.6853	-.748	-1.105
	249.307	-1.3819	-1.404	-.87	-1.57
	199.484	-1.1053	-1.1234	-.714	-1.612
	149.582	-.8288	-.842	-.522	-1.57
	99.7467	-.5511	-.5616	-.416	-1.879
	49.8886	-.277	-.2805	-.137	-1.234

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450

SCALE FACTOR (V/DEG/SEC): -5.63233E-03

BIAS (VOLTS) : 1.88592E-04

HYSTERESIS, NEG RATES (VDC): -2.96712E-03

HYSTERESIS, POS RATES (VDC): 7.01904E-04

NULL OFFSET (VDC): -2.17223E-03

TEST ENGINEER [signature]

3-17-80

READY

TABLE 3.4.2-V

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE..3-17-80..... RUN....COLD.....

TEMP...-30°F..... SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.8992	.2799	.2945	.511	-5.119
*	-99.8536	.5569	.5798	.8	-4.337
	-149.666	.8371	.8643	.953	-3.152
	-199.524	1.134	1.1491	.876	-2.196
	-249.402	1.4118	1.4339	.774	-1.551
	-299.243	1.7236	1.7186	.524	-.876
	-349.177	1.9996	2.0038	.149	-.213
	-399.338	2.3001	2.2886	-.432	.584
	-448.947	2.6071	2.5737	-1.171	1.304
	-498.808	2.9195	2.8584	-2.139	2.144
	-448.841	2.6315	2.5731	-.997	1.11
	-398.942	2.2927	2.2881	-.163	.285
	-349.177	1.9929	2.0038	.458	-.647
	-299.289	1.6962	1.7189	.792	-1.324
	-249.428	1.4068	1.4341	.955	-1.915
	-199.555	1.1284	1.1492	1.038	-2.595
	-149.661	.8393	.8643	.873	-2.917
	-99.7542	.5629	.5792	.641	-3.211
	-49.9396	.2797	.2947	.443	-4.438
*	49.8491	-.2716	-.2753	-.129	-1.294
	99.7602	-.5485	-.5633	-.415	-2.079
	149.591	-.8348	-.845	-.518	-1.782
	199.534	-1.1396	-1.1382	-.703	-1.811
	249.349	-1.3931	-1.4147	-.756	-1.516
	299.261	-1.6648	-1.6998	-.687	-1.147
	349.095	-1.974	-1.9844	-.366	-.524
	399.437	-2.2711	-2.2695	.453	.367
	448.911	-2.5775	-2.5546	.883	.895
	498.757	-2.8865	-2.8393	1.654	1.652
	448.858	-2.572	-2.5543	.622	.693
	398.97	-2.2656	-2.2693	-.13	-.103
	349.134	-1.9668	-1.9845	-.641	-.918
	299.163	-1.6734	-1.6993	-.934	-1.511
	249.437	-1.3875	-1.4151	-.964	-1.933
	199.452	-1.1053	-1.1297	-.857	-2.149
	148.687	-.8271	-.8455	-.646	-2.158
	99.767	-.5587	-.5634	-.339	-1.698
	49.8638	-.2771	-.2754	.062	.62

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -5.71161E-03

BIAS (VOLTS) : 9.446678-03

HYSTERESIS, NEG RATES (VDC): -4.03674E-03

HYSTERESIS, POS RATES (VDC): 5.53429E-03

NULL OFFSET (VDC): 4.93338E-03

TEST ENGINEER.....

3-17-80

READY

TABLE 3.4.2-VI

RATE SENSOR PROGRAM: OUTPUT DRIFT **NADC 80081-60**

DATE...3-17-80..... RUN...cold.....

TEMP....-30°F..... SER#..355.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8523	.562869	5.631317E-03
99.7665	.561388	5.627038E-03
99.8836	.565372	5.664065E-03
99.8874	.564995	5.659785E-03
199.57	1.12914	5.657885E-03
199.548	1.12587	5.648316E-03
199.511	1.12734	5.653954E-03
199.547	1.12459	5.635735E-03
299.324	1.71352	5.71461E-03
299.275	1.70941	5.711543E-03
299.271	1.70163	5.685833E-03
299.273	1.70479	5.696448E-03
399.061	2.3251	5.776[illegible]E-03
399.048	2.34705	5.7911[illegible]E-03
399.053	2.3451	5.776[illegible]E-03
399.05	2.33389	5.[illegible]E-03
498.815	2.95835	5.91[illegible]E-03
498.743	2.96338	5.941695E-03
498.866	2.97112	5.955795E-03
498.792	2.95398	5.[illegible]E-03

FULL OFFSET (VDC): 1.473[illegible]E-03

MEAN

3-17-80

TABLE 3.4.2-VII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE...3-14-80..... RUN...COLD.....

TEMP...-30°F..... SER#...373.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.7721	.561648	5.62931E-03
99.8254	.556452	5.57426E-03
99.8279	.561911	5.62879E-03
99.7812	.570312	5.71562E-03
199.529	1.14836	5.75534E-03
199.525	1.1543	5.78526E-03
199.539	1.14438	5.73512E-03
199.577	1.15338	5.77913E-03
299.271	1.7706	5.91638E-03
299.265	1.7494	5.84566E-03
299.238	1.72554	5.76645E-03
299.22	1.71062	5.71695E-03
399.046	2.31766	5.80799E-03
399.076	2.33096	5.84139E-03
399.051	2.3263	5.82953E-03
399.047	2.33229	5.84466E-03
498.778	2.99902	6.01273E-03
498.835	3.01079	6.03566E-03
498.747	2.98534	5.98567E-03
498.792	2.96457	5.94349E-03

NULL OFFSET (VDC): -1.76195E-03

READY

Boyd W. Cummings
3-14-80

TABLE 3.4.2-VII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

DATE..3-17-80..... RUN...COLD.....

TEMP..-30°F..... SER#..381.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.7462	.543208	5.44591E-03
99.8239	.54366	5.44619E-03
99.7665	.543851	5.45123E-03
99.7452	.543602	5.44991E-03
199.541	1.1005	5.51514E-03
199.511	1.10699	5.54851E-03
199.539	1.10554	5.54045E-03
199.508	1.10587	.305543
299.252	1.68049	5.61564E-03
299.275	1.68079	5.61619E-03
299.276	1.68285	5.62358E-03
299.337	1.68351	5.62413E-03
398.995	2.27936	.305712
399.017	2.27965	5.69562E-03
399.039	2.26967	5.68784E-03
399.036	2.2709	5.69197E-03
498.795	2.89099	5.79594E-03
498.827	2.88462	5.78281E-03
498.737	2.88183	5.77826E-03
498.752	2.87971	5.77382E-03

NULL OFFSET (VDC): -3.88153E-03

READY

Boyd W. Cumpton 3-17-80

TABLE 3.4.2-IX

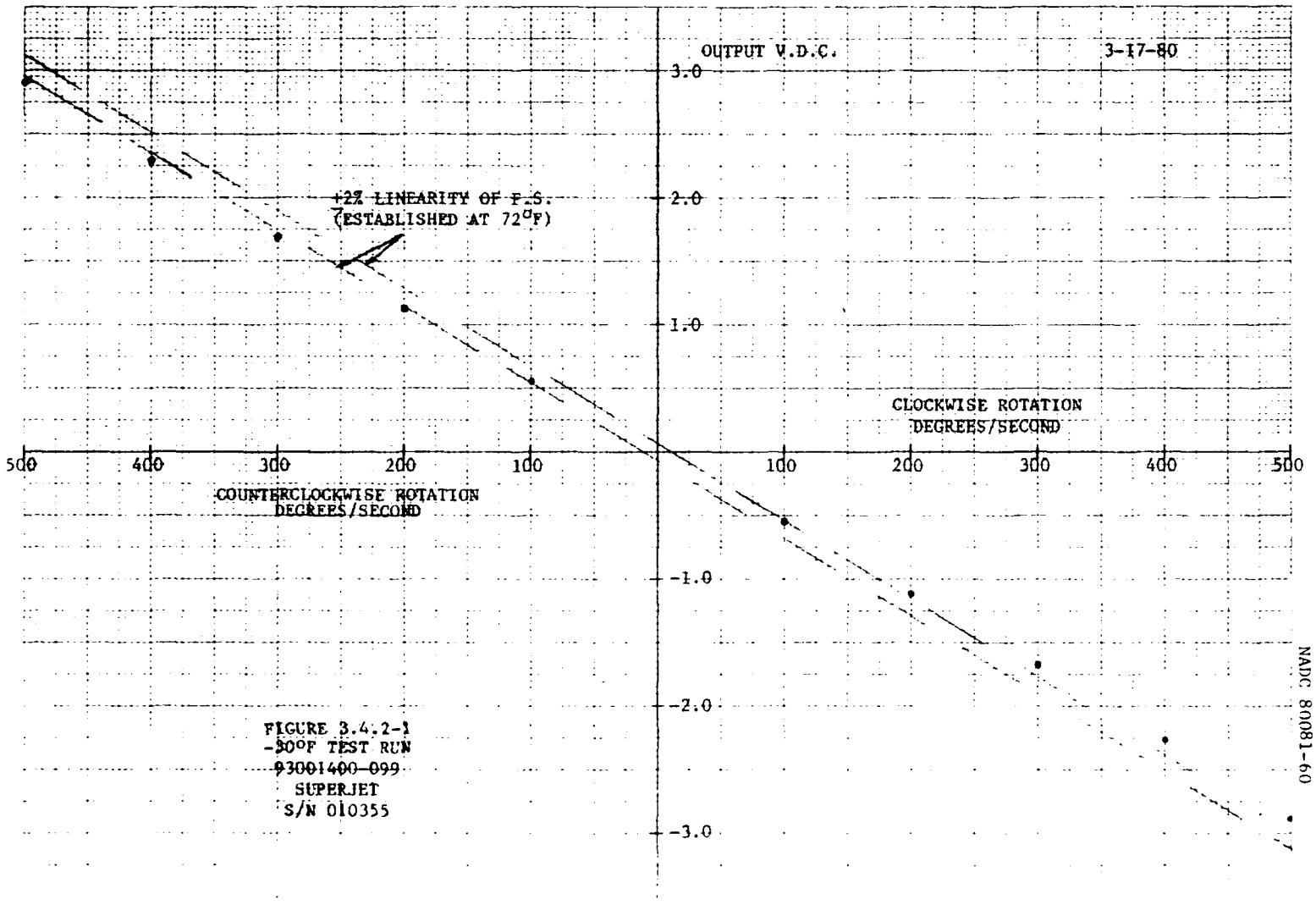


FIGURE 3.4.2-1
-30°F TEST RUN
93001400-099
SUPERJET
S/N 010355

NADC 80081-60

COLD TEMPERATURE TEST DATA
(-30°F)

PARAMETER	S/N 355	S/N 373	S/N 381
FULL SCALE RATE (DEG/SECOND) AT ±2% LINEARITY ERROR	450	400	450
SCALE FACTOR (MV/DEG/SEC) AT BASELINE RATE	-5.70	-5.90	-5.71**
BIAS (DEG/SECOND)	-1.31	-1.66	-1.65
HYSTERESIS CCW (DEG/SECOND)	2.25	.17	.70
HYSTERESIS CW (DEG/SECOND)	-2.44	-.65	-.97
NULL OFFSET (DEG/SECOND)	-.43	-.19	-.84
THRESHOLD (DEG/SECOND)	<0.10	<0.10	<0.10
RESOLUTION (DEG/SECOND)	<0.10	<0.10	<0.10
READYTIME (SECONDS) AVG. OF 5 RATES*	.067	.069	.068
DRIFT (DEG/SEC/MIN) AVG. OF 5 RATES*	+1.08 (RANDOM)	+.82 (RANDOM)	+.61 (RANDOM)

*100, 200, 300, 400, AND 500 DEGREES/SECOND (See Table 3.4.3-II)
**DATA FROM 500 DEG/SEC RUN

TABLE 3.4.3-I

COLD TEMPERATURE DRIFT AND READYTIME
(-30°F)

RATE (DEG/SEC)	OUTPUT DRIFT (DEG/SEC/MIN)			READYTIME (SECONDS)		
	355	373	381	355	373	381
100	+2.65	+4.79	+0.19	.068	.068	.070
200	+0.52	-3.40	+2.34	.068	.070	.065
300	-1.81	-4.51	+0.19	.065	.069	.070
400	+3.20	+0.82	+0.85	.068	.070	.070
500	+1.32	+3.12	-0.52	.065	.070	.065

TABLE 3.4.3-II

3.5 Sensitivity Jerk

3.5.1 Test Setup and Procedure

The test setup for the constant change in acceleration is the same as in the acceleration sensitivity test. The only difference is in the computer programming. A test schematic is shown in Figure D.2-1 in Appendix A.

The computer was programmed to accelerate the rate table from 0 degrees/second to 1000 degrees/second by incrementing the angular rates in 0.015 degree/second increments. The units were subjected to counterclockwise and clockwise rates.

The angular velocity was then incremented by .030 degree/second increments to double the jerk rate. Three more increments were used, i.e. .045, .060, and .075 degree/second. This method allowed each unit to be subjected to 5 different jerk rates. Data was taken at approximately 250 degrees/second and 500 degrees/second rates, only since higher rates cause saturation. The test procedure is discussed in Appendix A, Part D.

3.5.2 Test Results

Data could only be taken at multiples of the rate increments. As a result, the actual rates for each jerk are:

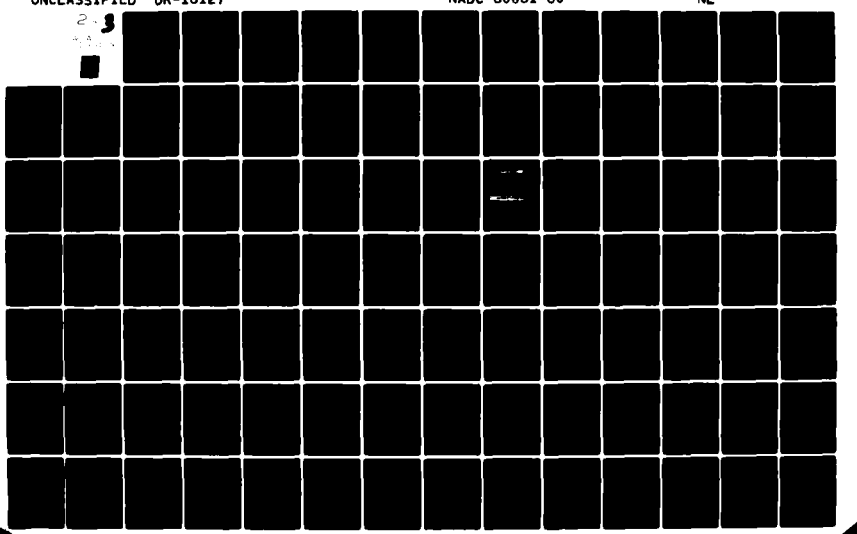
RATE INCREMENT °/SEC	JERK	RUN TIME APPROXIMATE	250°/SEC	500°/SEC
.015	1	11.7	250.5	501.0
.030	2	5.8	252.0	501.0
.045	3	3.9	252.0	504.0
.060	4	2.9	252.0	504.0
.075	5	2.4	255.0	502.5

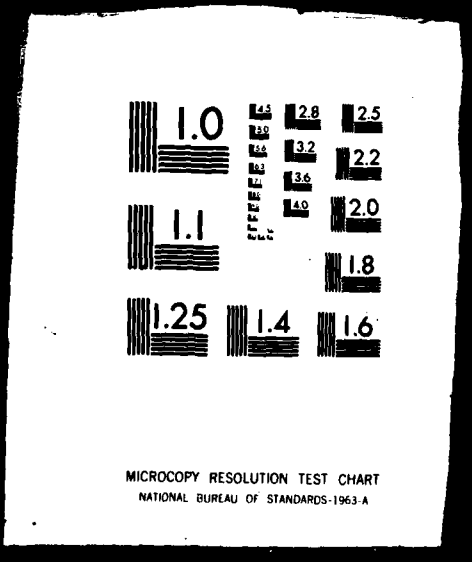
Using the actual rates, the output may be corrected for evaluation by transforming all data to the nominal rates. This is done by using the nominal scale factor of each unit. It is not known if the scale factor remains constant from one jerk value to the next. However, if the scale factor changes by $\pm 1\%$, the output would change only by $\pm .01\%$. Historical data shows the scale factor on sensor serial number 355 at 500 degrees/second maximum rate changes by 3.6% which is equivalent to .1 degree/second for 250 degrees/second rate and .18 degree/second for 500 degrees/second rate.

However, the repeatibility of the sensor has varied up to 19 millivolts at 500 degrees/second (post acoustic baseline, S/N 381), which enters into the Jerk evaluation.

The data collected for each direction and serial number is shown in Tables 3.5.2-I through 3.5.2-XXIV. Data was obtained at 750, 500 and 250 degrees/second rates.

AD-A091 089 MARTIN MARIETTA AEROSPACE ORLANDO FL F/G 1/3
PERFORMANCE VERIFICATION OF THE 'SUPERJET' LAMINAR ANGULAR RATE--ETC(U)
MAY 80 B W CURRY DAAK40-79-D-0017
UNCLASSIFIED OR-16127 NADC-80081-60 NL





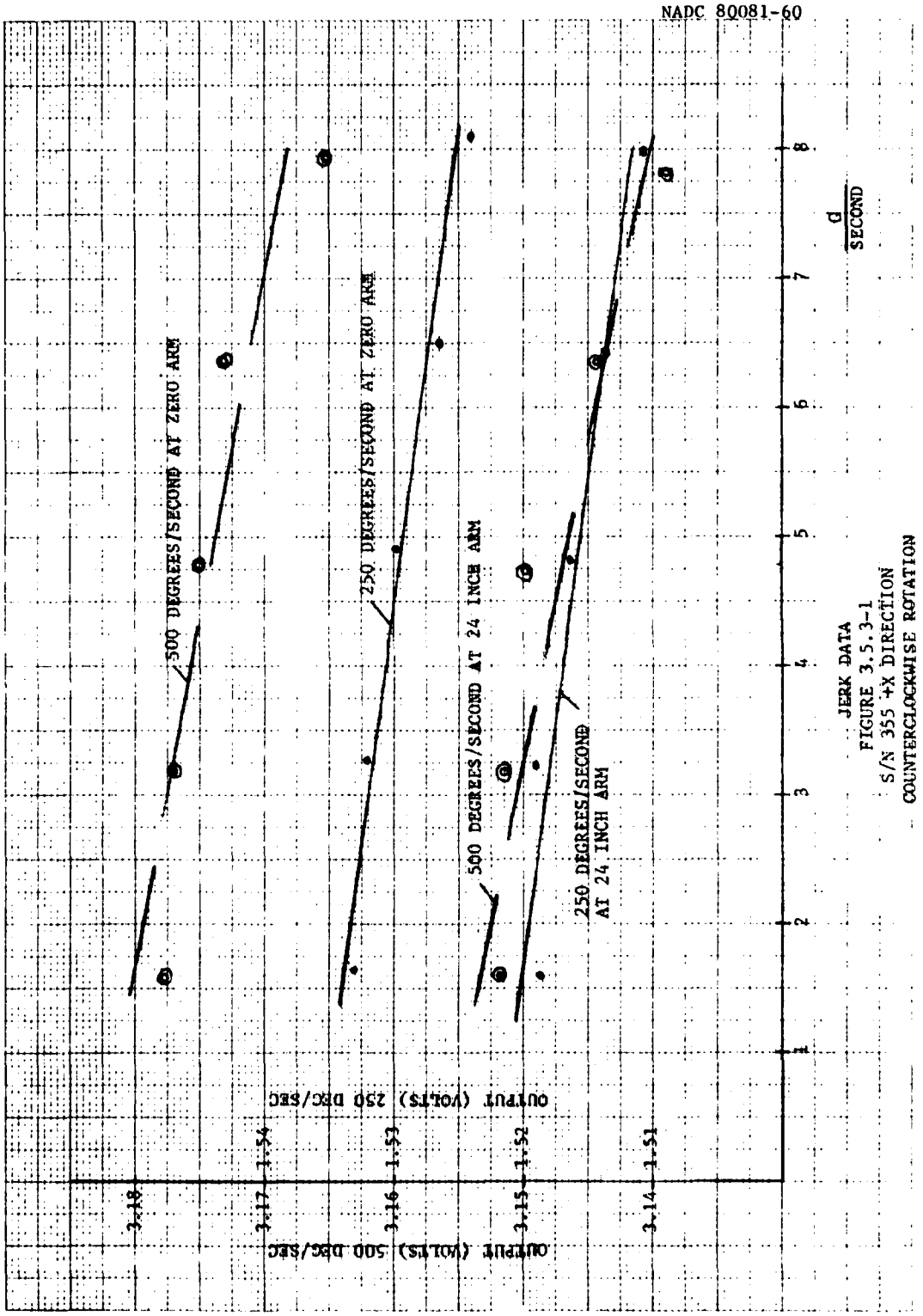
3.5.3 Data Evaluation

It is evident that the change of acceleration (jerk) sensitivity on the Superjet is so small that it is concealed in the repeatibility of each sensor, which has been measured to be 31 mv at 500 degrees/second rate from one setup to another setup.

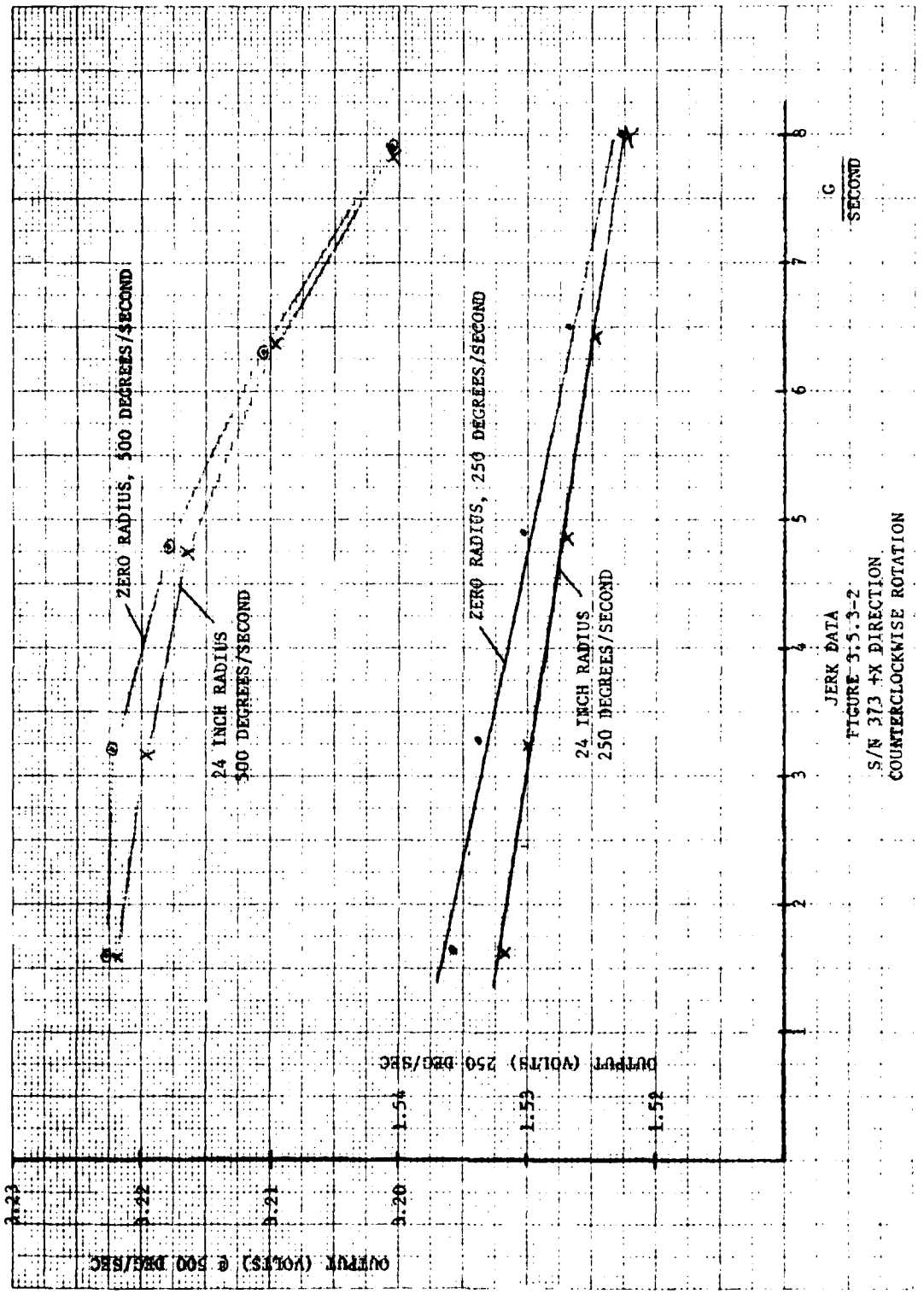
This is shown typically by Figures 3.5.3-1 and 3.5.3-2, which is for the positive X direction rotating counterclockwise and for serial numbers 355 and 373.

Serial number 355 shows a large delta between the zero arm run and the 24 inch arm, but the gap is constant, therefore indicating neglible jerk sensitivity. The gap on serial number 373 is small which also indicates neglible jerk sensitivity.

The slope of the data points do suggest that there may be an angular acceleration sensitivity. The highest value of the two sensors occurs for serial number 373 at the 500 degrees/second reading. The change in output is = 22.0 millivolts which is equivalent to 3.47 degrees/second shift from $\dot{\omega}$ = 87 degrees/second^2 to 427 degrees/second^2. This reduces to an angular acceleration sensitivity of 0.01 degrees/second/degree/second^2.



JERK DATA
FIGURE 3.5.3-1
S/N 355 +X DIRECTION
COUNTERCLOCKWISE ROTATION



JERK DATA
FIGURE 3.5.3-2
S/N 373 +X DIRECTION
COUNTERCLOCKWISE ROTATION

```
RUN    3-20-80          R = 24 in.
SER#...355.....AXIS.....X.....NULL VOLTS..-9.6MV.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

10.148           9.055            4.0007           1.5591
6.081            4.675            4.0033           3.11462
4.073            3.126            4.0064           4.65214
3.36             2.351            4.071            6.18954
2.466            1.939            4.014            7.69345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

10.161           9.089            -4.0058          1.55744
6.1              4.69             -4.0069          3.13492
4.086            3.136            -4.0072          4.63534
3.071            2.359            -4.0074          6.16737
2.473            1.915            -4.0077          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1582           1.59186
5.966            3.131            3.1578           3.17466
3.998            2.116            3.1749           4.73737
3.204            1.598            3.1694           6.30483
2.42             1.285            3.1546           7.80645

READY
-1--RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1294          1.58653
5.986            3.141            -3.129           3.16435
4.012            2.123            -3.1466          4.72084
3.016            1.634            -3.1415          6.27984
2.403            1.289            -3.1269          7.80366

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5218           1.6245
5.848            1.6              1.5317           3.23871
3.819            1.284            1.5229           4.8341
2.845            .825             1.5061           6.43104
2.371            .676             1.5418           7.98819

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.689           3.145            -1.5306          1.61294
5.869            1.636            -1.5193          3.20713
3.832            1.307            -1.5167          4.81629
2.855            .827             -1.5139          6.43946
2.38             .679             -1.53            7.98798

READY
```

JERK DATA
TABLE 3.5.2-I

```
RUN      3-20-80          R + 24 in.
SER#.....355.....AXIS.....Z.....NULL VOLTS...+4.2MV.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.148           9.295            4.8703           1.5591
6.081            4.675            4.8053           3.11468
4.073            3.126            4.8695           4.65014
3.36             2.351            4.8538           6.17954
2.466            1.909            4.8972           7.68245

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RERR
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.163           9.299            -4.0265          1.55718
6.1              4.69             -4.0276          3.13492
4.086            3.136            -4.028           4.63534
3.071            2.359            -4.0282          6.16737
2.473            1.915            -4.0286          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.896           6.217            3.1544           1.59213
5.967            3.131            3.1521           3.17412
3.998            2.116            3.1715           4.73737
3.336            1.599            3.1651           6.30373
2.42             1.285            3.1513           7.92645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RERR
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.131           1.58653
5.936            3.141            -3.1333          3.16445
4.311            2.122            -3.1486          4.72231
3.316            1.634            -3.1433          6.27904
2.428            1.289            -3.1282          7.88266

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.613           2.528            1.2145           1.63393
5.825            1.268            1.2198           3.2515
3.903            .832             1.2233           4.85268
2.934            .678             1.2314           6.45535
2.363            .548             1.2198           8.31523

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RERR
?2.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.655           2.537            -1.2053          1.60538
5.845            1.292            -1.206           3.24438
3.916            .804             -1.2134          4.83657
2.944            .68              -1.2197          6.43342
2.371            .55              -1.2083          7.99819

READY
```

JERK DATA
TABLE 3.5.2-II

```
RUN       3-20-80        R = 24 in.
SER#.....356.....AXIS...??.....NULL VOLTS.+4.00..

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.123           9.269            4.8817           1.56232
6.001            4.675            4.8993           3.11462
4.373            3.126            4.8826           4.65014
3.86             2.351            4.8679           6.18954
2.465            1.989            4.9117           7.68357

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -4.8249          1.55731
6.181            4.69             -4.8259          3.10441
4.386            3.136            -4.8264          4.63534
3.871            2.359            -4.8266          6.16737
2.473            1.915            -4.827           7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1564           1.59186
5.966            3.131            3.1568           3.17466
3.998            2.116            3.1738           4.73737
3.384            1.598            3.1697           6.30493
2.42             1.285            3.1596           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1284          1.58653
5.987            3.141            -3.1279          3.16352
4.311            2.122            -3.1452          4.72281
3.415            1.604            -3.1436          6.28192
2.428            1.289            -3.1258          7.80866

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5232           1.6245
5.848            1.6              1.5324           3.23871
3.917            1.083            1.5305           4.83533
2.945            .825             1.5295           6.43124
2.372            .676             1.5458           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
??.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.539           1.61894
5.869            1.606            -1.5193          3.22713
3.932            1.087            -1.5171          4.81689
2.955            .827             -1.514           6.40948
2.38             .679             -1.5299          7.95798

READY
```

JERK DATA
TABLE 3.5.2-III

```
RUN     3-20-80          R = 24 in.
SER#.....366.............AXIS....Y.........NULL VOLTS.11.20..

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.149           9.295            4.8367           1.55898
6.081            4.675            4.8954           3.11462
4.072            3.125            4.8814           4.65128
3.06             2.351            4.8664           6.18954
2.465            1.909            4.9002           7.68357

READY
RUN
SER#.....................AXIS.............NULL VOLTS........

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.163           9.299            -4.028           1.55718
6.101            4.69             -4.029           3.10441
4.086            3.136            -4.0294          4.63534
3.071            2.359            -4.0296          6.16737
2.474            1.915            -4.0299          7.65562

READY
RUN
SER#.....................AXIS.............NULL VOLTS........

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1582           1.59186
5.967            3.131            3.1597           3.17412
3.998            2.116            3.1749           4.73737
3.006            1.599            3.1789           6.30073
2.42             1.285            3.1586           7.82645

READY
RUN
SER#.....................AXIS.............NULL VOLTS........

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1382          1.58653
5.988            3.141            -3.1381          3.16299
4.012            2.123            -3.153           4.72884
3.016            1.604            -3.1497          6.27984
2.428            1.289            -3.1347          7.80066

READY
RUN
SER#.....................AXIS.............NULL VOLTS........

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5234           1.6245
5.848            1.6              1.5332           3.23871
3.917            1.083            1.5389           4.83533
2.945            .825             1.5281           6.43124
2.372            .676             1.5441           7.98482

READY
RUN
SER#.....................AXIS.............NULL VOLTS........

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.512           1.61694
5.869            1.606            -1.5215          3.22713
3.932            1.087            -1.519           4.81689
2.955            .827             -1.5174          6.40948
2.38             .679             -1.5328          7.95798

READY
```

JERK DATA
TABLE 3.5.2-IV

RUN 3-20-80 R = 24.4 in.
SER#.....355.....AXIS.....Z.....NULL VOLTS.+3.7##..

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
10.103	9.27	-.039909	1.64143
6.002	4.676	-.212677	3.27179
4.074	3.127	-.339058	4.88439
3.361	2.352	-.398541	6.53002
2.467	1.91	-.398141	8.26637

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.533
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
12.285	9.342	.017775	1.6304
6.144	4.733	.018235	3.23877
4.087	3.137	.016232	4.86885
3.072	2.36	.015202	6.47754
2.474	1.916	.015245	8.04325

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.941	6.261	-.007024	1.66644
5.967	3.132	-.006489	3.33484
3.999	2.117	-.005477	4.97599
3.005	1.599	-.004967	6.62196
2.421	1.286	-.004302	8.21933

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.333
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.98	6.281	.014991	1.66132
6.03	3.184	.015071	3.3
4.013	2.124	.012995	4.95863
3.017	1.635	.012093	6.59562
2.429	1.29	.01171	8.19226

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.533
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.731	3.178	-.002239	1.70362
5.849	1.631	-.001161	3.40212
3.918	1.384	-.000595	5.07887
2.946	.825	-.000116	6.75458
2.373	.677	.000461	8.38559

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.533
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.741	3.188	.009748	1.69403
5.912	1.649	.009628	3.36587
3.933	1.388	.007626	5.0595
2.956	.828	.007162	6.73173
2.381	.68	.006578	8.35741

READY

JERK DATA

TABLE 3.5.2-V

```
RUN      3-20-80    R = 23.6 in.
SER#.....355.....AXIS....+Z.....NULL VOLTS..+4.00V..

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.124           9.27             -.018536         1.53609
6.382            4.676            -.019367         3.06248
4.116            3.169            -.0186           4.52527
3.133            2.394            -.018493         6.00058
2.538            1.952            -.018773         7.42663

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.206           9.343            .028024          1.52597
6.132            4.691            .029303          3.05244
4.087            3.137            .029749          4.55738
3.072            2.36             .030377          6.06315
2.474            1.916            .031032          7.5287

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.941           6.261            -.009559         1.55984
6.01             3.174            -.010141         3.09917
4.041            2.159            -.010161         4.60925
3.049            1.642            -.010073         6.13809
2.463            1.328            -.010596         7.56232

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.982           6.281            .010055          1.5545
5.988            3.142            .009551          3.11855
4.013            2.124            .009174          4.64142
3.017            1.605            .009595          6.17368
2.409            1.29             .00101           7.66818

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.781           3.178            -.002606         1.59183
5.891            1.643            -.002788         3.16177
3.961            1.127            -.002777         4.72235
2.988            .868             -.002952         6.2336
2.415            .72              -.003002         7.71263

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.742           3.188            .003634          1.58627
5.87             1.607            .003534          3.17328
3.933            1.088            .003174          4.73508
2.956            .828             .003213          6.30138
2.381            .68              .002602          7.80076

READY
```

JERK DATA
TABLE 3.5.2-VI

S/N 355 R = 6 in.
+3.9MV
X and Y Axis

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.321          9.214           4.9058          1.57558
6.33            4.647           4.9210          3.14396
4.038           3.107           4.9069          4.69044
3.034           2.337           4.8917          6.24258
2.445           1.898           4.9344          7.74640

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.06           9.244           -4.0311         1.57048
6.049           4.662           -4.0321         3.1311
4.052           3.117           -4.0325         4.67423
3.045           2.345           -4.0327         6.22203
2.453           1.904           -4.0331         7.72116

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.768          6.181           3.1841          1.63945
5.902           3.113           3.1833          3.23908
3.955           2.103           3.2006          4.78887
2.973           1.589           3.1982          6.37367
2.393           1.277           3.1808          7.91475

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.000
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.808          6.201           -3.1636         1.604
5.922           3.123           -3.1624         3.19824
3.967           2.11            -3.1796         4.77439
2.982           1.594           -3.1731         6.35144
2.401           1.281           -3.1597         7.88838

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.5            3.116           1.5362          1.64696
5.77            1.591           1.5447          3.2825
3.864           1.077           1.5423          4.93166
2.905           .82             1.539           6.51979
2.34            .673            1.5552          8.09402

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?2.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.541          3.126           -1.5243         1.64111
5.789           1.596           -1.534          3.27172
3.879           1.081           -1.5313         4.8827
2.916           .802            -1.5284         6.4952
2.348           .675            -1.5433         8.06644

READY
```

JERK DATA
TABLE 3.5.2-VII

S/N 355 R = 0 in.
+3.1 MV
Z Axis

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.03       9.214        -.005661       1.5744
6.335       4.648        -.005699       3.13836
4.042       3.108        -.005309       4.6858
3.038       2.338        -.005929       6.23436
2.448       1.899        -.006481       7.73693

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.111      9.286        .011204        1.56387
6.356       4.663        .010696        3.12748
4.056       3.118        .010364        4.66963
3.049       2.346        .010593        6.21187
2.456       1.905        .011011        7.71173

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.828      6.223        -.00241        1.60128
5.911       3.113        -.002609       3.2042
3.962       2.104        -.002671       4.78041
2.978       1.59         -.002688       6.35997
2.439       1.32         -.003025       7.76548

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.868      6.243        .008308        1.59539
5.932       3.124        .00831         3.19285
3.975       2.111        .008308        4.76478
2.988       1.595        .008481        6.33869
2.406       1.282        .008439        7.87199

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.57       3.159        .000283        1.63699
5.784       1.592        .000232        3.27455
3.875       1.078        .0004          4.88774
2.955       .863         .000295        6.40948
2.347       .673         .000356        8.06988

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.612      3.17         .006073        1.63107
5.834       1.597        .006035        3.26327
3.888       1.081        .00593         4.8714
2.923       .823         .005797        6.47964
2.355       .676         .005765        8.04246

READY
```

JERK DATA
TABLE 3.5.2-VII

```
RUN      3-20-80      R = 24 in.
SER#.....373.....AXIS.....+X.....NULL VOLTS..-6.###.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.148           9.295            4.9422           1.5591
6.081            4.675            4.9488           3.11462
4.073            3.126            4.9315           4.65214
3.06             2.351            4.9138           6.18954
2.466            1.929            4.9521           7.68045

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.163           9.299            -4.2351          1.59718
6.101            4.69             -4.2361          3.13441
4.086            3.136            -4.2365          4.63534
3.271            2.359            -4.2367          6.16737
2.473            1.915            -4.237           7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.2283           1.59186
5.967            3.131            3.2259           3.17412
3.998            2.116            3.2419           4.73737
3.005            1.599            3.2359           6.30283
2.42             1.285            3.2192           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.2326          1.58653
5.986            3.141            -3.1986          3.16435
4.012            2.123            -3.2155          4.72384
3.016            1.684            -3.2287          6.27984
2.428            1.289            -3.192           7.80366

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.139            1.5348           1.6245
5.848            1.6              1.5427           3.23871
3.917            1.083            1.5396           4.83533
2.945            .825             1.5374           6.43124
2.37             .677             1.5538           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.5364          1.61894
5.869            1.636            -1.5449          3.22713
3.932            1.087            -1.5417          4.81689
2.955            .827             -1.5384          6.43948
2.38             .679             -1.5543          7.95798

READY
```

JERK DATA
TABLE 3.5.2-IX

```
RUN     3-20-80      R = 24 in.
SER#.....373.....AXIS.....Z.....NULL VOLTS..-6.394.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.182          9.269           4.9319          1.56245
6.481           4.675           4.9447          3.11462
4.373           3.126           4.9273          4.65414
3.36            2.351           4.9114          6.18954
2.466           1.909           4.9481          7.69045

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?7.533
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.162          9.299           -4.0362         1.55731
6.131           4.69            -4.0371         3.10441
4.086           3.136           -4.0376         4.63534
3.071           2.359           -4.0377         6.16737
2.473           1.915           -4.033          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.897          6.217           3.2368          1.592
5.966           3.131           3.2345          3.17466
3.998           2.116           3.2492          4.73737
3.005           1.599           3.2427          6.32283
2.42            1.285           3.2245          7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.333
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.938          6.238           -3.228          1.58653
5.987           3.141           -3.2055         3.16352
4.012           2.123           -3.2198         4.72384
3.016           1.604           -3.2131         6.27984
2.428           1.289           -3.1972         7.83866

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.533
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.659          3.135           1.5483          1.6245
5.848           1.6             1.5482          3.23871
3.917           1.083           1.5447          4.83533
2.945           .825            1.542           6.43124
2.372           .676            1.5573          7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.533
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.699          3.145           -1.5433         1.61894
5.868           1.626           -1.5489         3.22713
3.932           1.087           -1.5453         4.81609
2.955           .827            -1.5423         6.40948
2.38            .679            -1.5583         7.95798

READY
```

JERK DATA
TABLE 3.5.2-X

```
RUN      3-20-80      R = 24 in.
SER#.....373.....AXIS...+Y.....NULL VOLTS..-5.00V.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.123           9.269            4.9356           1.56232
6.081            4.675            4.9489           3.11462
4.073            3.126            4.9333           4.65014
3.06             2.351            4.9157           6.18954
2.466            1.909            4.9536           7.68345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -4.0332          1.55731
6.1              4.69             -4.0341          3.10492
4.086            3.136            -4.0345          4.63534
3.071            2.359            -4.0347          6.16737
2.473            1.915            -4.035           7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1--
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.2286           1.59186
5.967            3.131            3.2248           3.17412
3.998            2.116            3.242            4.73737
3.005            1.599            3.236            6.30283
2.42             1.285            3.2173           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1981          1.58653
5.986            3.141            -3.1929          3.16485
4.012            2.123            -3.21            4.72084
3.016            1.604            -3.2833          6.27984
2.428            1.289            -3.1852          7.80066

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.658           3.135            1.5342           1.62464
5.848            1.6              1.5417           3.23871
3.917            1.083            1.538            4.83533
2.945            .825             1.5344           6.43124
2.372            .677             1.5518           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.5336          1.61894
5.869            1.636            -1.5421          3.22713
3.932            1.087            -1.5395          4.81689
2.955            .827             -1.5358          6.4094R
2.38             .679             -1.5527          7.95798

READY
```

JERK DATA
TABLE 3.5.2-XI

```
RUN        3-20-80      R = 24 in.
SER#.....373.....AXIS....Y.....NULL VOLTS...-6.2MV.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.530
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.148           9.295            4.9837           1.5591
6.881            4.675            4.9338           3.11462
4.372            3.125            4.912            4.65128
3.36             2.351            4.894            6.18954
2.466            1.929            4.9336           7.68345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?7.530
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -4.8333          1.55731
6.131            4.69             -4.8344          3.13441
4.086            3.136            -4.8348          4.69534
3.071            2.359            -4.835           6.16737
2.473            1.915            -4.8353          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.300
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.2205           1.59186
5.966            3.131            3.2173           3.17466
3.998            2.116            3.2352           4.73737
3.005            1.599            3.226            6.30283
2.42             1.285            3.2287           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?5.300
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.936           6.238            -3.1994          1.58653
5.987            3.141            -3.1966          3.16352
4.012            2.123            -3.2123          4.72384
3.016            1.634            -3.2056          6.27984
2.428            1.289            -3.1891          7.80066

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.530
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5347           1.6245
5.848            1.6              1.5425           3.23871
3.917            1.083            1.5388           4.83533
2.945            .825             1.5362           6.43124
2.372            .676             1.5521           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?2.530
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.5352          1.61894
5.869            1.606            -1.544           3.22713
3.932            1.087            -1.541           4.81609
2.955            .827             -1.5369          6.42894
2.38             .679             -1.5534          7.95798

READY
```

JERK DATA
TABLE 3.5.2-XII

```
RUN      3-20-80        R = 23.6 in
SER#.....373.....AXIS...+Z.....NULL VOLTS...-6.00.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.151           9.297            -.071795         1.53289
6.124            4.718            -.072166         3.04148
4.116            3.169            -.072315         4.52527
3.104            2.395            -.071864         6.00364
2.508            1.952            -.072547         7.42663

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
27.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.163           9.3              .036632          1.53137
6.143            4.733            .036302          3.03287
4.129            3.179            .0361            4.51102
3.114            2.402            .035952          5.98137
2.516            1.958            .036356          7.40302

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
25.833
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.941           6.261            -.051583         1.55984
6.011            3.175            -.051291         3.09865
4.042            2.159            -.051506         4.63812
3.049            1.642            -.051605         6.10689
2.463            1.328            -.051301         7.56232

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
25.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.982           6.281            .02747           1.5545
6.029            3.184            .027739          3.0894
4.055            2.166            .027718          4.59334
3.059            1.647            .028026          6.08898
2.471            1.332            .027717          7.53784

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.781           3.178            -.028887         1.59183
5.892            1.644            -.029388         3.16124
3.961            1.127            -.029079         4.73235
2.988            .868             -.029136         6.2336
2.415            .72              -.02933          7.71263

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
??.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.742           3.188            .013287          1.58627
5.912            1.649            .013135          3.15054
3.975            1.13             .012934          4.68579
2.998            .87              .013743          6.21081
2.423            .722             .013026          7.68717

READY
```

JERK DATA
TABLE 3.5.2-XIII

RUN 3-20-80 R = 24.4 in.
SER#.....373.....AXIS....Z.....NULL VOLTS...-6.0V

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
12.124	9.27	-.062962	1.64129
6.123	4.718	-.063503	3.24988
4.116	3.169	-.063977	4.83455
3.134	2.395	-.063172	6.41876
2.529	1.953	-.063812	7.98135

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?7.500

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
12.285	9.342	.029515	1.6304
6.144	4.733	.029638	3.23877
4.129	3.179	.029284	4.81933
3.114	2.402	.029893	6.39817
2.516	1.958	.030049	7.98098

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.330

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.941	6.261	-.048714	1.66644
6.01	3.174	-.048593	3.31898
4.041	2.159	-.048976	4.92428
3.049	1.642	-.04891	6.5264
2.463	1.328	-.048264	8.07917

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?5.330

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.981	6.281	.025032	1.66088
6.03	3.184	.025178	3.3
4.055	2.166	.025287	4.90727
3.059	1.647	.024836	6.52587
2.471	1.332	.025079	8.05381

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.530

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.721	3.178	-.028365	1.70062
5.892	1.644	-.028375	3.37729
3.961	1.127	-.028707	5.02373
2.988	.868	-.028585	6.63964
2.415	.72	-.028912	8.23975

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
RCDR
?2.530

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.741	3.138	.013089	1.69483
5.912	1.649	.013524	3.36587
3.974	1.13	.013593	5.0373
2.998	.87	.013386	6.63742
2.424	.722	.013399	8.23916

READY

JERK DATA
TABLE 3.5.2-XIV

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.02           9.214           4.9292          1.57571
6.03            4.647           4.9464          3.14096
4.038           3.137           4.9285          4.69044
3.034           2.337           4.9387          6.24258
2.445           1.898           4.9487          7.74642

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.06           9.244           -4.0372         1.57048
6.049           4.662           -4.0382         3.1311
4.052           3.117           -4.0386         4.67423
3.045           2.345           -4.0389         6.22003
2.453           1.904           -4.0391         7.72116

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.300
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.794          6.207           3.2338          1.6059
5.902           3.113           3.229           3.20938
3.955           2.103           3.243           4.78687
2.973           1.589           3.235           6.37067
2.393           1.277           3.2197          7.91475

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.300
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.808          6.201           -3.2056         1.604
5.922           3.123           -3.2031         3.19824
3.967           2.11            -3.2183         4.77439
2.983           1.594           -3.2117         6.34931
2.4             1.281           -3.195          7.89167

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?3.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.5            3.116           1.539           1.64696
5.77            1.591           1.5466          3.2825
3.864           1.077           1.543           4.90166
2.905           .82             1.5394          6.51979
2.34            .673            1.5544          8.09402

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?3.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.54           3.126           -1.54           1.64125
5.79            1.596           -1.5473         3.27116
3.878           1.08            -1.5442         4.88396
2.916           .822            -1.5435         6.4952
2.348           .675            -1.5561         8.06644

READY
```

S/N 373 R = 0 in.
-6.5MV
X and Y Axis

JERK DATA

TABLE 3.5.2 -XV

S/N 373 R = 0 in.
-6.2 MV
Z Axis

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.072      9.256        -.054157       1.56892
6.077       4.69         -.05421        3.11667
4.084       3.15         -.054414       4.63761
3.081       2.381        -.054396       6.14735
2.49        1.941        -.054896       7.62643

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.113      9.287        .016855        1.56361
6.056       4.663        .016281        3.12748
4.056       3.118        .015863        4.66963
3.049       2.346        .01644         6.21187
2.456       1.905        .016551        7.71173

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.828      6.223        -.040132       1.60128
5.953       3.155        -.039801       3.18159
4.003       2.146        -.039996       4.73145
3.32        1.632        -.040111       6.27152
2.439       1.32         -.039936       7.76548

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.869      6.244        .015467        1.59575
5.932       3.124        .015383        3.19285
3.975       2.111        .01532         4.76478
2.988       1.595        .015043        6.33869
2.405       1.282        .015055        7.87526

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.572      3.16         -.023495       1.63671
5.825       1.634        -.023523       3.2515
3.917       1.12         -.023523       4.83533
2.956       .863         -.023544       6.40731
2.389       .716         -.023518       7.928

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.611      3.169        .007952        1.63121
5.804       1.597        .0078          3.26327
3.888       1.081        .007748        4.8714
2.923       .823         .007719        6.47964
2.355       .676         .007778        8.04246

READY
```

JERK DATA
TABLE 3.5.2-XVI

```
RUN     3-20-80          R = 24 in.
SER#.....001.....AXIS.....Z.....NULL VOLTS.-11.501.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.148          9.295           4.7724          1.5591
6.081           4.675           4.7798          3.11462
4.073           3.126           4.7632          4.65314
3.06            2.351           4.7425          6.18954
2.466           1.939           4.779           7.68345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.162          9.299           -3.999          1.55731
6.131           4.69            -4.0001         3.10441
4.086           3.136           -4.3005         4.63534
3.071           2.359           -4.3006         6.16737
2.473           1.915           -4.001          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.897          6.217           3.1297          1.592
5.967           3.131           3.1291          3.17412
3.998           2.116           3.1404          4.73737
3.305           1.599           3.1346          6.30283
2.42            1.265           3.1206          7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?5.333
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.938          6.238           -3.1436         1.58653
5.986           3.141           -3.1434         3.16435
4.012           2.123           -3.1546         4.72084
3.016           1.604           -3.1474         6.27984
2.426           1.289           -3.1324         7.80866

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.583
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.658          3.135           1.583           1.62464
5.847           1.6             1.5107          3.23927
3.917           1.083           1.5074          4.83533
2.945           .825            1.5046          6.43124
2.372           .676            1.5233          7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CONT
?2.583
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.699          3.145           -1.5249         1.61894
5.869           1.636           -1.5339         3.22713
3.932           1.087           -1.5336         4.81609
2.955           .827            -1.5274         6.43946
2.38            .679            -1.5427         7.95798

READY
```

JERK DATA
TABLE 3.5.2-XVII

```
RUN       3-20-80        R = 24 in.
SER#.....301.....AXIS....X.....PULL VOLTS.-11.500.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.123           9.269            4.7474           1.56232
6.381            4.675            4.7615           3.11468
4.372            3.185            4.7441           4.65108
3.36             2.351            4.7372           6.18954
2.466            1.909            4.7638           7.68345

READY
RUN
SER#.....AXIS.....PULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -3.9989          1.55731
6.1              4.69             -4               3.12492
4.286            3.136            -4.0033          4.63534
3.371            2.359            -4.2033          6.16737
2.473            1.915            -4.0008          7.65871

READY
RUN
SER#.....AXIS.....PULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1263           1.59186
5.967            3.131            3.1245           3.17412
3.998            2.116            3.1397           4.73737
3.304            1.596            3.1343           6.30493
2.42             1.285            3.1175           7.82645

READY
RUN
SER#.....AXIS.....PULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1404          1.58653
5.987            3.141            -3.1379          3.16352
4.012            2.123            -3.1523          4.72384
3.316            1.634            -3.1468          6.27934
2.408            1.289            -3.1301          7.83366

READY
RUN
SER#.....AXIS.....PULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?3.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5034           1.6245
5.847            1.6              1.5129           3.23927
3.917            1.033            1.51             4.83533
2.945            .625             1.5069           6.43124
2.372            .677             1.5232           7.98482

READY
RUN
SER#.....AXIS.....PULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?3.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.5036          1.61094
5.869            1.636            -1.5325          3.22713
3.932            1.087            -1.5092          4.81689
2.955            .627             -1.5059          6.43948
2.38             .679             -1.5416          7.95798

READY
```

JERK DATA
TABLE 3.5.2-XVII

```
RUN        3-20-80     R = 24 in.
SER#.....381.....AXIS.....YY.....NULL VOLTS..-12.1.9V

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.538
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.149           9.295            4.7668           1.55898
6.081            4.675            4.7734           3.11462
4.072            3.125            4.7503           4.65128
3.06             2.351            4.7412           6.18954
2.466            1.939            4.7777           7.68345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -3.999           1.55731
6.101            4.69             -4.0001          3.13441
4.086            3.136            -4.0004          4.63534
3.071            2.359            -4.0005          6.16737
2.473            1.915            -4.0009          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1301           1.59186
5.967            3.131            3.1312           3.17412
3.998            2.116            3.1444           4.73737
3.036            1.599            3.1397           6.30073
2.42             1.285            3.1225           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.1429          1.58653
5.986            3.141            -3.1432          3.16435
4.012            2.123            -3.1534          4.72084
3.016            1.624            -3.1479          6.27984
2.428            1.289            -3.1317          7.80366

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5033           1.6245
5.848            1.6              1.5126           3.23871
3.917            1.383            1.539            4.83533
2.945            .825             1.5066           6.45104
2.372            .677             1.5223           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.699           3.145            -1.5259          1.61894
5.869            1.636            -1.5325          3.22713
3.932            1.087            -1.5293          4.81689
2.955            .827             -1.523           6.43948
2.38             .679             -1.5405          7.95798

READY
```

JERK DATA
TABLE 3.5.2-XIX

```
RUN       3-20-80        R = 24 in.
SER#.....381.....AXIS.....Y.....NULL VOLTS.-11.89V

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.148           9.295            4.7519           1.5591
6.381            4.675            4.7577           3.11462
4.373            3.126            4.7411           4.65814
3.36             2.351            4.7239           6.18954
2.466            1.939            4.7596           7.68345

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

12.162           9.299            -3.9997          1.55731
6.131            4.69             -4.0038          3.13441
4.386            3.136            -4.0011          4.63534
3.371            2.359            -4.0012          6.16737
2.473            1.915            -4.0017          7.65871

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.898           6.218            3.1262           1.59186
5.967            3.131            3.1248           3.17412
3.998            2.116            3.1383           4.73737
3.005            1.599            3.1338           6.32283
2.42             1.285            3.1158           7.82645

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.333
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.938           6.238            -3.146           1.58653
5.987            3.141            -3.1445          3.16352
4.011            2.122            -3.1577          4.70031
3.016            1.604            -3.1555          6.27984
2.423            1.289            -3.1576          7.88366

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.66\
2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.659           3.135            1.5046           1.6245
5.848            1.6              1.5125           3.23871
3.917            1.083            1.539            4.83533
2.945            .825             1.5057           6.43124
2.372            .676             1.5037           7.98482

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.533
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.698           3.145            -1.5063          1.61236
5.869            1.606            -1.5344          3.22713
3.932            1.087            -1.5313          4.81609
2.955            .827             -1.5079          6.43948
2.38             .679             -1.5407          7.95798

READY
```

JERK DATA
TABLE 3.5.2-XX

RUN 3-20-80 R = 23.6 in.
SER#.....381.....AXIS...Z.....NULL VOLTS.:12.39V.

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.503
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
12.124	9.27	-.343638	1.53629
6.124	4.718	-.343738	3.34148
4.116	3.169	-.343357	4.52527
3.104	2.395	-.343747	6.30364
2.536	1.952	-.343835	7.48663

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?7.503
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
12.236	9.343	.022869	1.52597
6.101	4.691	.022128	3.05294
4.087	3.137	.021213	4.55738
3.072	2.36	.022106	6.06315
2.474	1.916	.022468	7.5287

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.333
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.941	6.261	-.029817	1.55984
6.21	3.174	-.029751	3.09917
4.042	2.159	-.029882	4.60812
3.049	1.642	-.030195	6.10889
2.463	1.328	-.029866	7.56232

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?5.333
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.981	6.281	.008142	1.55463
5.988	3.142	.008612	3.11055
4.012	2.123	.008861	4.64257
3.016	1.635	.009339	6.17573
2.429	1.29	.009494	7.66818

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.538
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.781	3.178	-.020764	1.59183
5.892	1.644	-.020881	3.16124
3.961	1.127	-.021103	4.70235
2.989	.868	-.021149	6.23152
2.416	.72	-.021186	7.70944

READY
RUN
SER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CDR
?2.538
RUN TIME | MEAS TIME | V OUT (VDC) | G DOT

RUN TIME	MEAS TIME	V OUT (VDC)	G DOT
11.748	3.168	-.032627	1.58627
5.87	1.637	-.032266	3.17328
3.933	1.086	-.031083	4.73582
2.956	.828	-.031962	6.30133
2.371	.68	-.031643	7.82276

READY

JERK DATA
TABLE 3.5.2-XXI

```
RUN        3-20-80        R = 24.4 in.
USER#.....381.....AXIS.....Z.....NULL VOLTS:12.00V..

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7,500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

10.165           9.312            -.031675         1.63576
6.220            4.676            -.031191         3.27179
4.116            3.169            -.032469         4.83455
3.061            2.352            -.030000         6.50389
2.466            1.91             -.029395         8.36934

READY
RUN
USER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CCR
?7,500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

10.035           9.342            .014418          1.6304
6.144            4.733            .013368          3.23877
4.087            3.137            .011595          4.86805
3.072            2.36             .01116           6.47754
2.474            1.916            .010629          8.04325

READY
RUN
USER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5,000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.941           6.261            -.027379         1.66644
5.967            3.132            -.026582         3.33404
4.041            2.159            -.026923         4.82428
3.049            1.642            -.028138         6.5264
2.481            1.286            -.025396         8.21933

READY
RUN
USER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CCR
?5,000
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.981           6.281            .006146          1.66388
6.03             3.184            .005899          3.3
4.218            2.123            .003855          4.95987
3.217            1.625            .003667          6.59562
2.489            1.29             .00224           8.19026

READY
RUN
USER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2,500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.731           3.178            -.020852         1.70262
5.892            1.644            -.020884         3.37729
3.961            1.127            -.020998         5.02373
2.988            .868             -.020962         6.65964
2.415            .72              -.021176         8.23975

READY
RUN
USER#.....AXIS.....NULL VOLTS.....

ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?CCR
?2,500
RUN              MEAS             V OUT            G DOT
TIME             TIME             (VDC)

11.742           3.188            -.033329         1.69469
5.912            1.649            -.033477         3.36587
3.933            1.303            -.033556         5.0595
2.956            .828             -.03364          6.73173
2.371            .68              -.033648         8.35741

READY
```

JERK DATA
TABLE 3.5.2-XXII

S/N 381 R = 0 in.
-11.8MV
X and Y Axis

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.32       9.214        4.7526         1.57571
6.03        4.647        4.7649         3.14096
4.038       3.107        4.7476         4.69044
3.234       2.337        4.7301         6.24258
2.445       1.898        4.7655         7.74642

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
12.361      9.244        -3.9969        1.57835
6.049       4.662        -3.9981        3.1311
4.051       3.117        -3.9984        4.67539
3.045       2.345        -3.9986        6.22033
2.453       1.904        -3.999         7.72116

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.768      6.181        3.143          1.60945
5.902       3.113        3.1414         3.20908
3.955       2.103        3.1538         4.78887
2.973       1.589        3.147          6.37067
2.393       1.277        3.1318         7.91475

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.000
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.808      6.221        -3.1641        1.604
5.922       3.123        -3.156         3.19824
3.968       2.11         -3.1724        4.77318
2.982       1.594        -3.1653        6.35144
2.4         1.281        -3.1492        7.89167

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.5        3.116        1.5121         1.64696
5.77        1.591        1.5197         3.2825
3.864       1.077        1.5152         4.90166
2.905       .82          1.512          6.51979
2.34        .673         1.5258         8.09402

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?2.500
RUN TIME    MEAS TIME    V OUT (VDC)    G DOT
11.542      3.127        -1.5379        1.64096
5.79        1.596        -1.5434        3.27116
3.878       1.08         -1.5402        4.88396
2.916       .822         -1.536         6.4952
2.348       .675         -1.5511        8.06644

READY
```

JERK DATA
TABLE 3.5.2-XXIII

S/N 381 R = 0 in.
-13.2MV
Z Axis

```
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.075          9.269           -.018603        1.56853
6.472           4.69            -.018442        3.11924
4.081           3.15            -.018491        4.64132
3.278           2.381           -.018446        6.15335
2.488           1.941           -.018582        7.61254

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?7.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

12.104          9.287           .001857         1.56477
6.05            4.663           .001763         3.13058
4.094           3.16            .002322         4.62628
3.046           2.346           .002044         6.21799
2.454           1.905           .001186         7.71801

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?5.000
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.811          6.224           -.018204        1.60359
5.945           3.156           -.018204        3.18587
3.998           2.147           -.018325        4.73737
3.015           1.632           -.018173        6.28192
2.437           1.321           -.018311        7.77185

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?5.000
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.351          6.244           -.003791        1.59818
5.965           3.166           -.004055        3.17519
3.969           2.111           -.004192        4.77198
3.225           1.637           -.00441         6.26116
2.402           1.282           -.004596        7.8851

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1
?2.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.545          3.16            -.016278        1.64054
5.812           1.634           -.016278        3.25877
3.908           1.12            -.016449        4.84647
2.949           .863            -.016557        6.42252
2.383           .716            -.016421        7.94796

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?1-
?
STOP

READY
RUN
ENTER 1 FOR CCW ROTATION; -1 FOR CW ROTATION ?-1
?2.500
RUN             MEAS            V OUT           G DOT
TIME            TIME            (VDC)

11.585          3.17            -.009092        1.63487
5.79            1.597           -.009357        3.27116
3.68            1.002           -.009538        4.80144
2.917           .823            -.009621        6.49297
2.349           .676            -.009697        8.06331
```

JERK DATA

READY

TABLE 3.5.2-XXIV

3.6 Acoustic Sensitivity

3.6.1 Test Setup and Procedure

The sensor units were mounted (one at a time) on a cantilever beam (aluminum channel) and positioned in the throat of the acoustic chamber. The jet axis (X - axis) of the sensor coincided with the direction of acoustic wave propagation and with the horizontal centerline of the chamber.

The unit was energized and a series of eight acoustic pulses (approximately 155 db for 10 seconds) were applied to the test area. Three microphones were placed within the test area under procedures outlined in MIL-STD-810C, Method 515.2. The null output of the unit was monitored throughout testing along with the input to the acoustic chamber.

A test schematic is shown in Figure E.2-1 of Appendix A, Part E of this report, with the test procedure.

The baseline tests were repeated to discover any anomolies caused by the acoustic environment. These tests were done as in Section 3.1 of this report.

3.6.2 Test Results

The octave analysis specification for the category D, 165 db acoustic test is shown in Figure 3.6.2-1.

The calibration of the acoustic chamber is shown in the octave analysis shown in Figure 3.6.2-2.

The octave analysis for the three microphones placed around the test specimen indicated an overall acoustic level of 155 db. (See Figures 3.6.2-3 to 3.6.2-5) This level was the highest that could be obtained for this setup. One of the acoustic drivers had to be replaced due to failure caused by pushing the limit of the equipment.

The output of the device was recorded on an occillograph. A typical graph is shown in Figure 3.6.2-6.

The post acoustic baseline test results are shown in Tables 3.6.2-I through 3.6.2-X. The data is in the same form as the initial baseline test data.

3.6.3 Data Evaluation

The acoustic environment had no effect on the null output of the device except for the increase in noise level. All three devices had a pretest noise level of 6.0 millivolts peak to peak. The overall average noise level during testing was 12.0 millivolts with no shift in the null D.C. output. The noise level of the null output was 6.0 milliovlts after the acoustic pulses, indicating no adverse effects on the Superjet sensor.

The worst case baseline data obatined for the three test units after the acoustic environmental test is as shown below:

1.	Full Scale Rate at ±2% Linearity Error	500 ±100 deg/sec
2.	Scale Factor	-.00630 ±.00002 V/deg/sec
3.	Bias	±1.07 deg/sec
4.	Hysteresis	±0.46 deg/sec
5.	Threshold	<0.10 deg/sec
6.	Resolution	<0.10 deg/sec
7.	Readytime	.071 seconds maximum
8.	Drift	+.75 deg/sec/min maximum
9.	Null Offset	±1.25 deg/sec

The fullscale rate increased by 9% on S/N 381 and the scale factor increased by 0.2 millivolts/degrees/second. The only substantial increase in the bias parameter occurred in S/N 381 as also shown in the null offset measurement. The null offset measurements were not taken during the initial baseline test. The calculated bias (least squares fit) value relates to null offset which is the voltage measured before the actual test sequence. Readytime has increased typically 50% over the initial baseline test but remains the same as measured in the hot and cold temperature tests. The drift of the sensors have increased approximately 265% over the inital baseline measurements. This may have been caused by the temperature test environments.

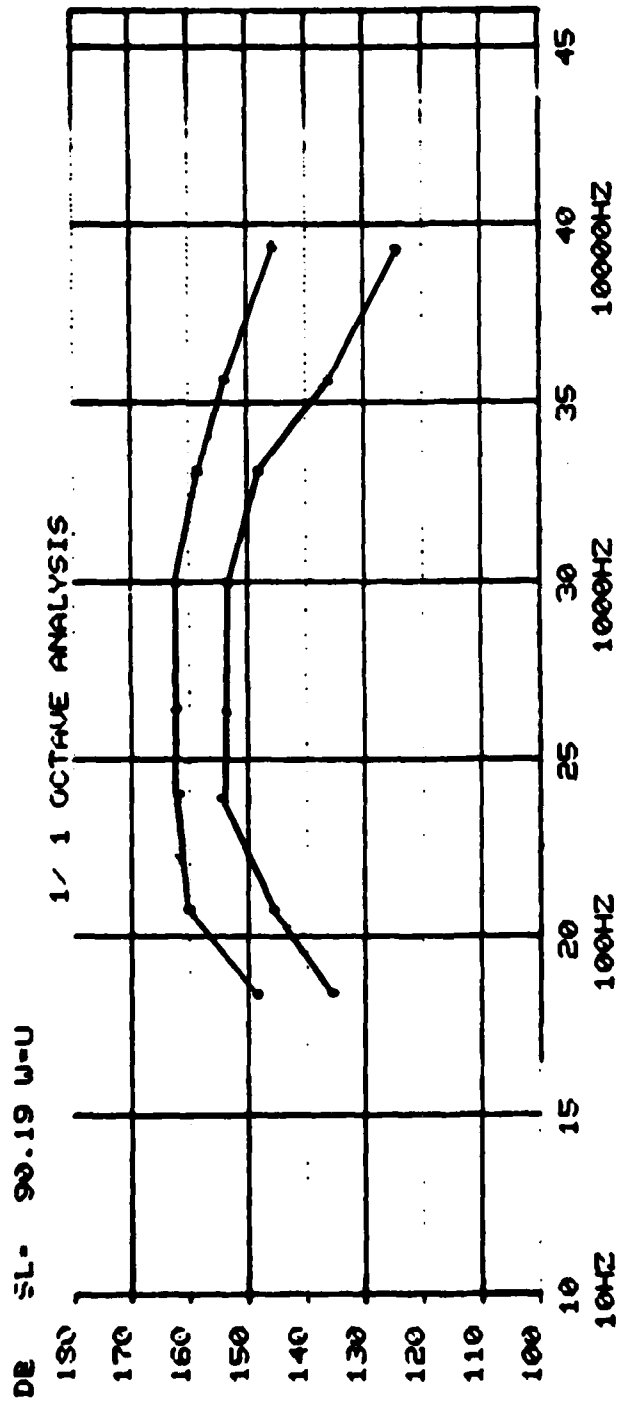
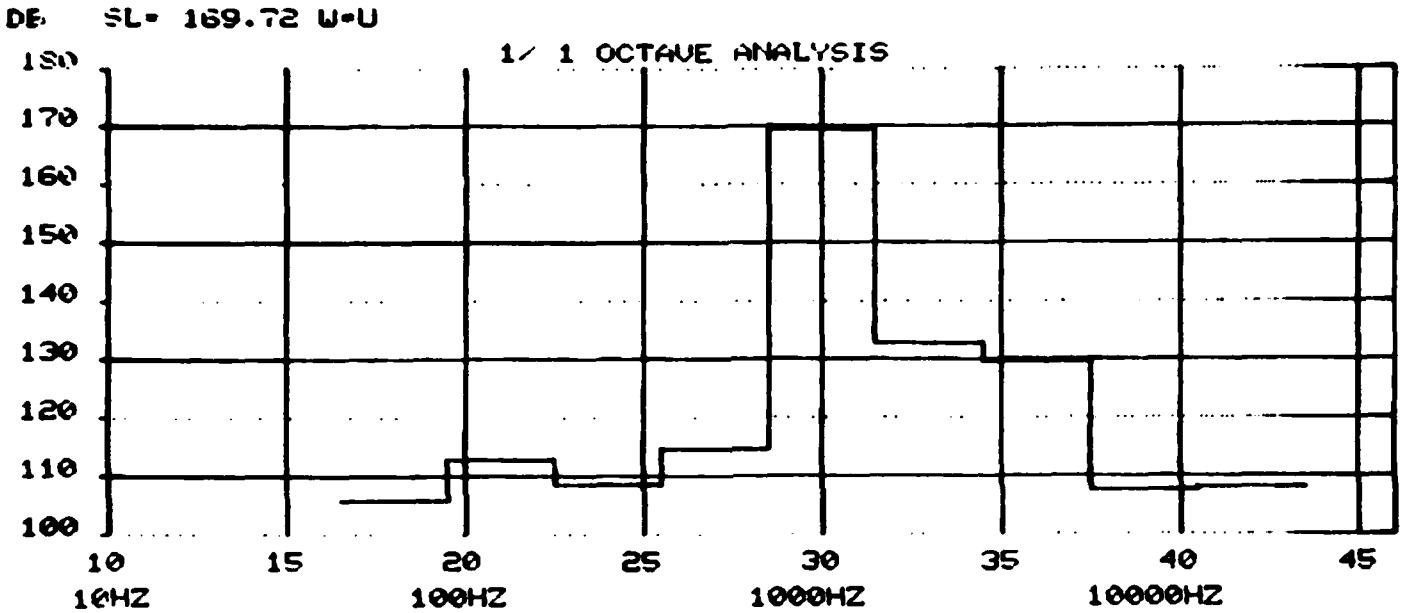


FIGURE 3.6.2-1

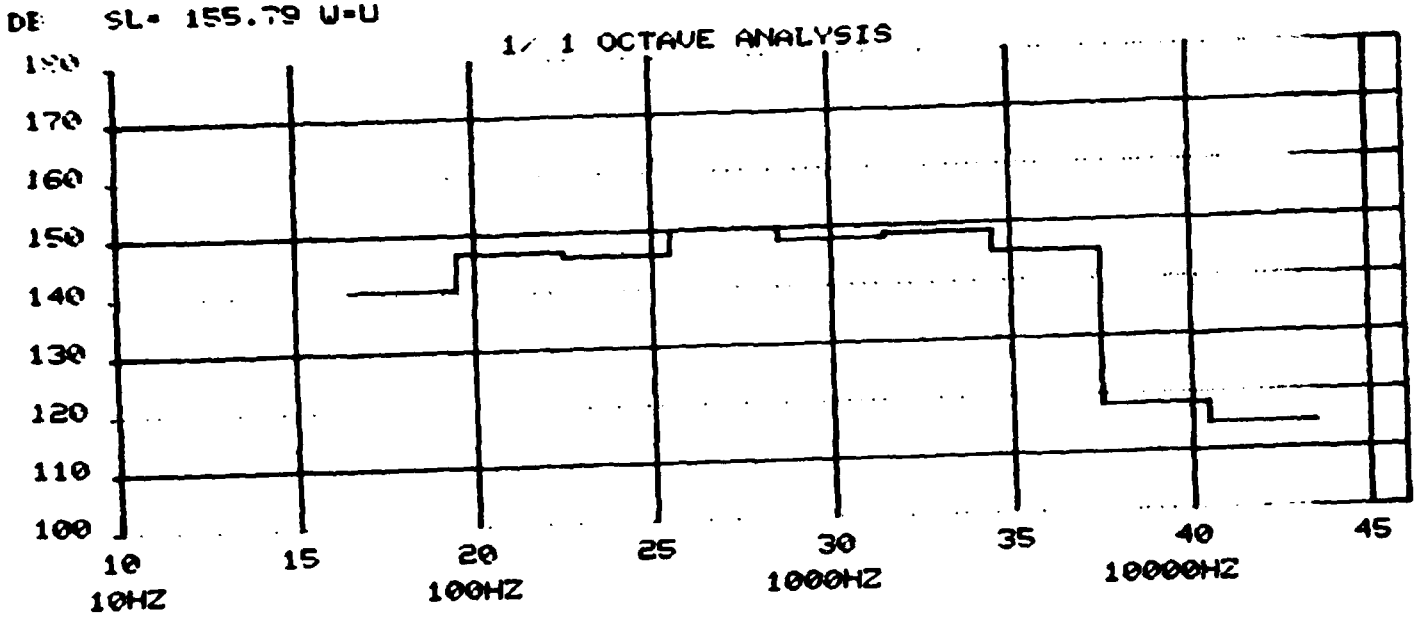
SPECIFICATION
MIL-STD-810C
METHOD 515.2
CATEGORY D



W=U	A=LI	N= 4 (4)	SL= 169.72
18.0	63.0	105.82	
21.0	125.0	112.77	
24.0	250.0	108.50	
27.0	500.0	114.65	
30.0	1000.0	169.71	
33.0	2000.0	132.92	
36.0	4000.0	129.76	
39.0	8000.0	107.50	
42.0	16000.0	108.16	

FIGURE 3.6.2-2

CALIBRATION 170 db
3-27-80
ACOUSTIC CHAMBER

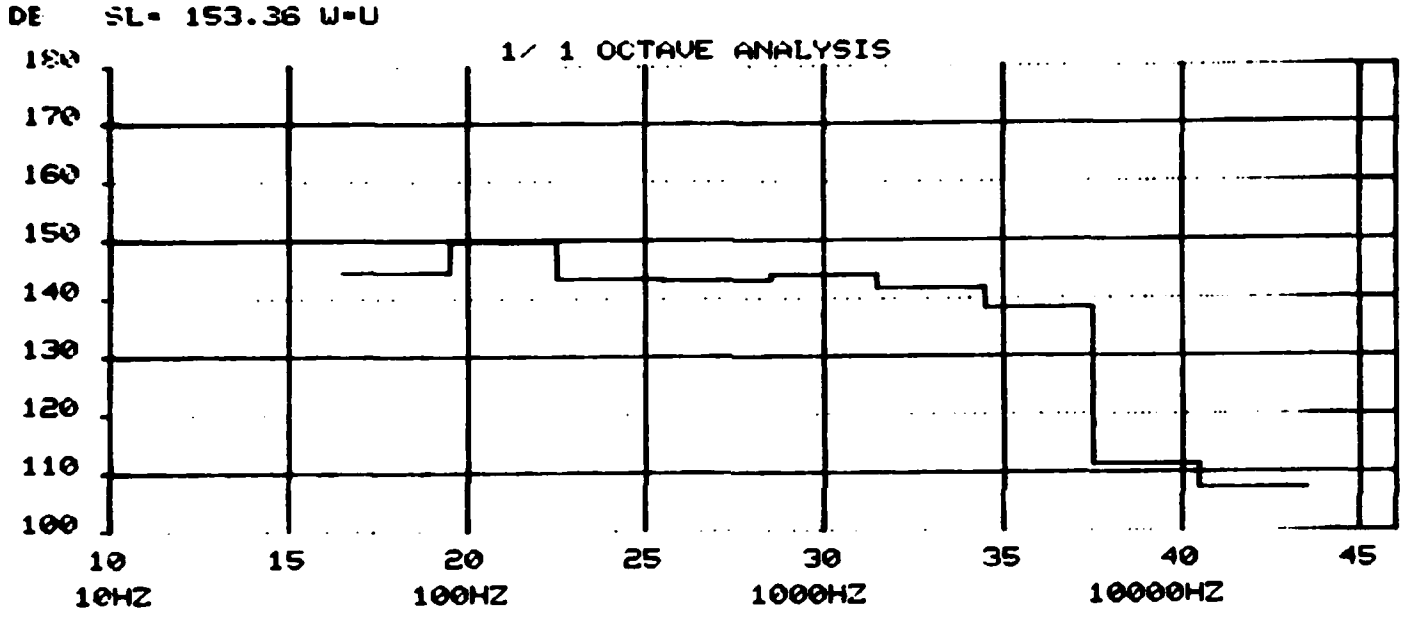


W-U A-LI N= 4 (4) SL= 155.79

18.0	63.0	140.74
21.0	125.0	146.88
24.0	250.0	145.96
27.0	500.0	150.11
30.0	1000.0	148.08
33.0	2000.0	148.80
36.0	4000.0	145.22
39.0	8000.0	118.38
42.0	16000.0	114.57

FIGURE 3.6.2-3

MICROPHONE NO. 1 CALIBRATION
3-27-80

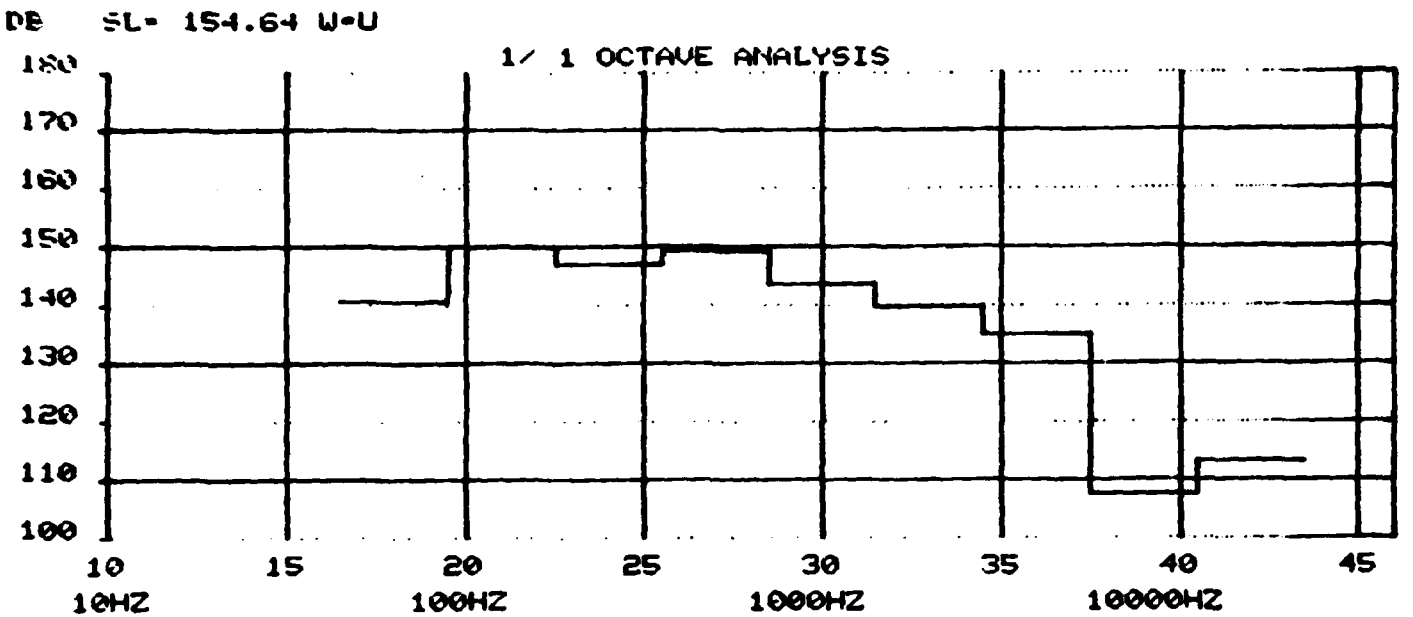


W=U W=LI N= 4 (4) SL= 153.36

18.0	63.0	144.61
21.0	125.0	149.80
24.0	250.0	143.50
27.0	500.0	143.25
30.0	1000.0	144.22
33.0	2000.0	141.93
36.0	4000.0	138.44
39.0	8000.0	111.49
42.0	16000.0	107.28

FIGURE 3.6.2-4

MICROPHONE NO. 2 CALIBRATION
3-27-80



W-U A-LI N= 4 (4) SL= 154.64

18.0	63.0	140.84
21.0	125.0	150.06
24.0	250.0	147.18
27.0	500.0	149.43
30.0	1000.0	143.79
33.0	2000.0	139.85
36.0	4000.0	135.14
39.0	8000.0	107.59
42.0	16000.0	113.35

FIGURE 3.6.2-5

MICROPHONE NO. 3 CALIBRATION
3-27-80

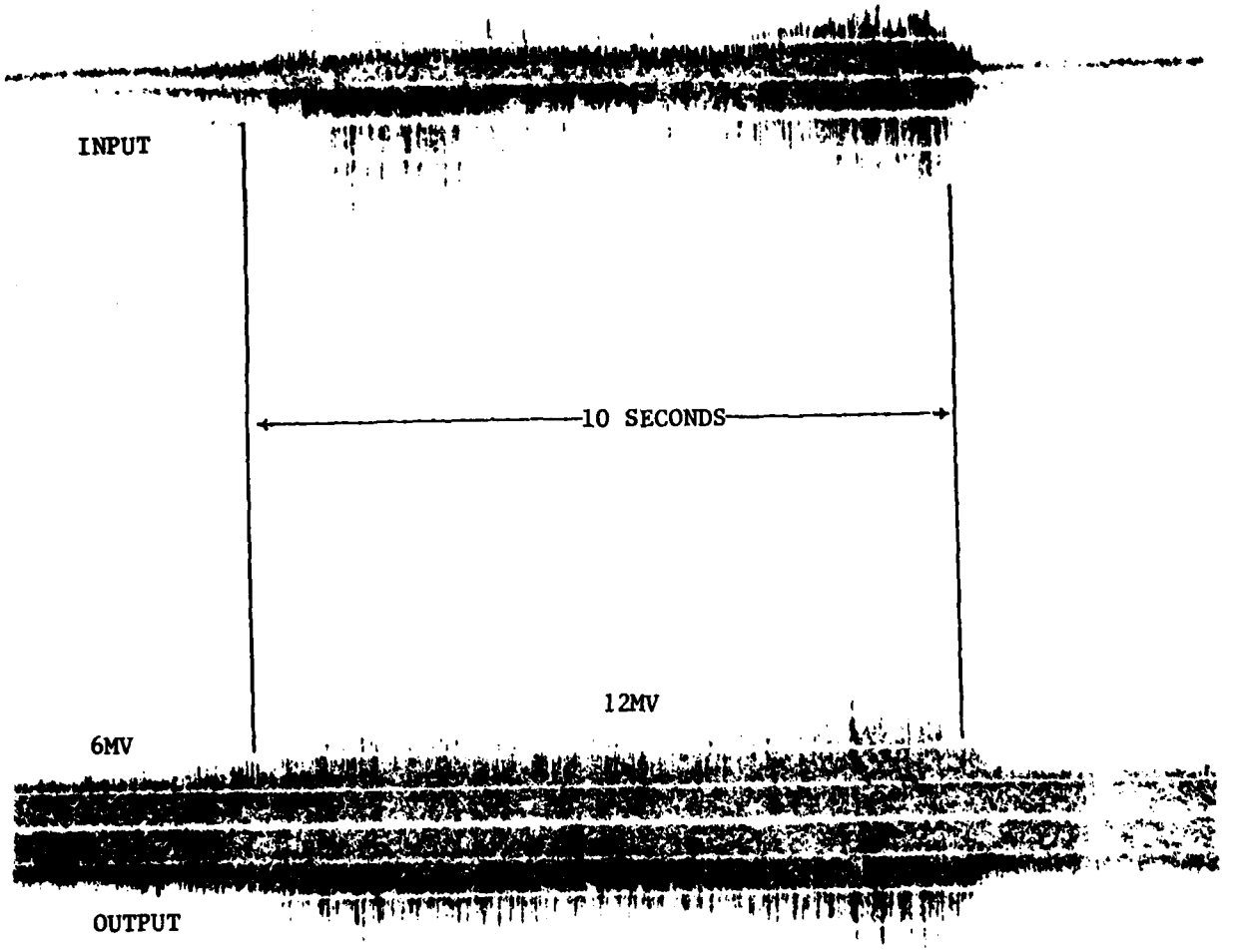


FIGURE 3.6.2-6

NULL OUTPUT VS. ACOUSTIC ENVIRONMENT
(TYPICAL)

RATE SENSOR TEST PROGRAM — POST ACOUSTIC — NADC 80081-60

DATE 3-22-80 RUN BASELINE

TEMP. 72°F 50%RH SER# 355

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-499.9886	.3068	.3181	.36	-3.637
	-399.1235	.6122	.6327	.649	-3.253
	-149.678	.8206	.947	.836	-2.793
	-199.587	1.2316	1.2616	.953	-2.387
*	-249.519	1.5471	1.5764	.93	-1.863
	-299.427	1.8673	1.8929	.749	-1.352
	-349.263	2.1935	2.2252	.371	-.531
	-399.121	2.5257	2.5195	-.196	.246
	-449.364	2.8644	2.8343	-.954	1.362
	-499.957	3.2095	3.1489	-1.924	1.929
	-449.15	2.8658	2.8349	-.979	1.39
	-399.188	2.5271	2.5199	-.229	.287
	-349.284	2.1956	2.2253	.338	-.441
	-299.399	1.8699	1.8938	.663	-1.128
	-249.549	1.55	1.5766	.844	-1.69
	-199.638	1.2343	1.2617	.868	-2.174
	-149.735	.9031	.9471	.761	-2.543
	-99.8371	.6145	.6327	.578	-2.897
	-49.9575	.3081	.3183	.324	-3.245
	49.8578	-.3026	-.311	-.264	-2.644
	99.6976	-.6087	-.6252	-.523	-2.623
	149.62	-.9168	-.9399	-.731	-2.444
*	199.574	-1.2275	-1.2548	-.867	-2.171
	249.452	-1.5421	-1.5692	-.86	-1.723
	299.276	-1.861	-1.8833	-.738	-1.183
	349.236	-2.1854	-2.1983	-.439	-.585
	399.11	-2.5155	-2.5127	.088	.111
	449.336	-2.8518	-2.8275	.773	.861
	498.929	-3.194	-3.142	1.649	1.653
	448.99	-2.8526	-2.8272	.808	.9
	399.105	-2.5167	-2.5127	.127	.16
	349.17	-2.187	-2.1979	-.344	-.492
	299.31	-1.8628	-1.8836	-.659	-1.121
	249.425	-1.544	-1.5691	-.796	-1.596
	199.542	-1.2293	-1.2546	-.831	-2.388
	149.637	-.9184	-.94	-.684	-2.285
	99.7636	-.6103	-.6256	-.486	-2.435
	49.8628	-.3038	-.311	-.227	-2.273

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500
SCALE FACTOR (V/DEG/SEC): -6.342121E-03
BIAS (VOLTS) : 3.352736E-03
HYSTERESIS, NEG RATES (VDC): -2.897986E-03
HYSTERESIS, POS RATES (VDC): 1.857766E-03
NULL OFFSET (VDC): 2.728875E-03

TEST ENGINEER Boyd W. Cusp 3-22-80

READY
RUN
SCALE FACTOR PROGRAM

TABLE 3.6.2-I

RATE SENSOR TEST PROGRAM NADC 80081-60

POST ACOUSTIC

DATE..3-27-80..... RUN..BASELINE.....

TEMP..72°F 50%RH... SER#..355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9462	.3054	.3189	.39	-4.09
	-99.8821	.61	.6342	.694	-3.885
	-149.784	.9173	.9496	.93	-3.417
	-199.592	1.2276	1.2648	1.071	-2.951
*	-249.584	1.542	1.5835	1.145	-2.435
	-299.431	1.8614	1.8959	.994	-1.886
	-349.311	2.1865	2.2112	.709	-1.117
	-399.269	2.5178	2.527	.263	-.362
	-449.183	2.8557	2.842	-.394	.488
	-498.964	3.1996	3.1572	-1.219	1.344
	-548.837	3.5488	3.47247	-2.196	2.2
	-498.998	3.2004	3.1574	-1.237	1.364
	-449.378	2.8569	2.8418	-.434	.531
	-399.218	2.5195	2.5267	.246	-.283
	-349.284	2.1867	2.211	.644	-1.413
	-299.456	1.8639	1.8961	.924	-1.698
	-249.539	1.5448	1.5836	1.133	-2.265
	-199.617	1.2343	1.265	.999	-2.751
	-149.764	.9199	.9499	.862	-3.167
	-99.8371	.6183	.6343	.633	-3.487
	-49.9362	.3068	.3189	.347	-3.824
	49.8518	-.302	-.3119	-.283	-3.187
	99.7296	-.6071	-.6272	-.577	-3.121
	149.571	-.9144	-.9422	-.8	-2.942
	199.51	-1.2244	-1.2579	-.965	-2.659
	249.469	-1.5381	-1.5737	-1.025	-2.26
*	299.273	-1.8558	-1.8885	-.938	-1.794
	349.175	-2.1794	-2.2039	-.726	-1.113
	399.075	-2.5083	-2.5193	-.317	-.437
	449.018	-2.8438	-2.835	.252	.308
	498.899	-3.1851	-3.1533	.999	1.191
	548.833	-3.53178	-3.46592	1.894	1.899
	498.87	-3.186	-3.1532	1.031	1.137
	448.955	-2.8451	-2.8346	.302	.37
	399.363	-2.5138	-2.5193	-.261	-.36
	349.232	-2.1813	-2.2043	-.661	-1.341
	299.075	-1.858	-1.8885	-.878	-1.613
	249.483	-1.5399	-1.5733	-.958	-2.114
	199.461	-1.2262	-1.2576	-.902	-2.486
	149.583	-.9163	-.9423	-.748	-2.749
	99.6976	-.6087	-.627	-.527	-2.925
	49.8504	-.3031	-.3119	-.252	-2.779

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550

SCALE FACTOR (V/DEG/SEC): -6.321328E-03

BIAS (VOLTS) : 3.238615E-03

HYSTERESIS, NEG RATES (VDC): -2.782585E-03

HYSTERESIS, POS RATES (VDC): 2.111678E-03

NULL OFFSET (VDC): 2.282838E-03

TEST ENGINEER 3-27-80

TABLE 3.6.2-II

RATE SENSOR TEST PROGRAM NADC 80081-60

POST ACOUSTIC

DATE..3-22-80..... RUN..BASELINE.....

TEMP..72°F..90%RH.. SER#...373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9431	.3012	.3137	.494	-3.958
	-99.8478	.61	.6289	.75	-3.385
*	-149.68	.922	.9437	.86	-2.229
	-199.553	1.2381	1.2586	.819	-1.641
	-249.548	1.5596	1.5744	.575	-.922
	-299.401	1.8886	1.8897	.358	-.378
	-349.292	2.2236	2.2348	-.751	.861
	-399.178	2.5669	2.5199	-1.861	1.865
	-349.881	2.2244	2.2347	-.781	.894
	-299.365	1.8892	1.8894	.044	-.336
	-249.535	1.5615	1.5744	.508	-.816
	-199.618	1.2398	1.2598	.768	-1.54
	-149.78	.9238	.9444	.816	-2.178
	-99.8869	.6115	.6288	.683	-2.739
	-49.9614	.3023	.3138	.453	-3.627
	49.8533	-.3123	-.3168	-.176	-1.409
	99.7087	-.6203	-.6317	-.451	-1.809
	149.618	-.9307	-.947	-.645	-1.726
*	199.518	-1.2441	-1.2622	-.718	-1.44
	249.337	-1.5624	-1.577	-.576	-.925
	299.271	-1.8861	-1.8924	-.25	-.334
	349.156	-2.2165	-2.2076	.353	.404
	399.056	-2.5539	-2.5223	1.232	1.235
	349.143	-2.2172	-2.2075	.385	.441
	299.275	-1.8869	-1.8924	-.218	-.291
	249.417	-1.5636	-1.5774	-.549	-.881
	199.474	-1.2456	-1.262	-.648	-1.3
	149.574	-.9317	-.9467	-.594	-1.589
	99.6976	-.6214	-.6316	-.406	-1.63
	49.8101	-.3131	-.3165	-.135	-1.081

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 400

SCALE FACTOR (V/DEG/SEC): -6.31732E-03

BIAS (VOLTS) : -1.89916E-03

HYSTERESIS, NEG RATES (VDC): -1.75536E-23

HYSTERESIS, POS RATES (VDC): 1.49465E-03

NULL OFFSET (VDC): -5.60225E-03

TEST ENGINEER [signature] 3-22-80

READY

TABLE 3.6.2-III

RATE SENSOR TEST PROGRAM

NADC 80081-60

DATE 3-27-80 RUN POST ACOUSTIC BASELINE

TEMP 72°F ...50%RH.. SER# ..373.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9348	.3008	.316	.534	-4.808
	-99.8784	.6091	.6332	.845	-3.805
	-149.688	.9208	.9496	1.008	-3.332
*	-199.644	1.2363	1.2666	1.06	-2.39
	-249.424	1.5578	1.5831	.886	-1.598
	-299.421	1.8857	1.9006	.521	-.783
	-349.27	2.2212	2.2173	-.137	.177
	-399.182	2.5641	2.5343	-1.043	1.176
	-449.139	2.9147	2.8514	-2.214	2.219
	-399.169	2.565	2.5342	-1.078	1.215
	-349.344	2.2223	2.2175	-.169	.218
	-299.385	1.8876	1.9004	.45	-.676
	-249.475	1.56	1.5834	.818	-1.476
	-199.585	1.2386	1.2665	.976	-2.2
	-149.764	.9228	.9501	.955	-2.868
	-99.7998	.6139	.6327	.765	-3.447
	-49.956	.3018	.3162	.538	-4.524
	49.8599	-.3105	-.3178	-.188	-1.683
	99.7585	-.6201	-.6348	-.514	-2.318
	149.616	-.9303	-.9514	-.74	-2.225
	199.535	-1.2436	-1.2683	-.963	-1.946
*	249.4	-1.5616	-1.5852	-.825	-1.459
	299.285	-1.885	-1.9021	-.597	-.896
	349.16	-2.2158	-2.2188	-.127	-.164
	399.066	-2.5524	-2.5358	.561	.655
	448.973	-2.8878	-2.8528	1.555	1.559
	399.097	-2.5531	-2.536	.599	.675
	349.234	-2.2163	-2.2193	-.104	-.134
	299.334	-1.8862	-1.9024	-.565	-.85
	249.378	-1.5631	-1.5851	-.768	-1.385
	199.539	-1.2451	-1.2665	-.818	-1.845
	149.683	-.9318	-.9515	-.689	-2.273
	99.7162	-.6215	-.6345	-.455	-2.454
	49.8536	-.3132	-.3178	-.159	-1.435

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450

SCALE FACTOR (V/DEG/SEC): -6.35151E-03

BIAS (VOLTS) : -1.13888E-03

HYSTERESIS, NEG RATES (VDC): -2.29526E-03

HYSTERESIS, POS RATES (VDC): 1.51515E-03

NULL OFFSET (VDC): -5.55475E-03

TEST ENGINEER [signature] 3-27-80

READY

TABLE 3.6.2-IV

RATE SENSOR TEST PROGRAM NADC 80081-60

POST ACOUSTIC

DATE 3-27-80 RUN BASELINE

TEMP 72°F 50%RH SER# 381

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9665	.2949	.3074	.36	-3.961
	-99.8641	.5988	.621	.642	-3.536
	-149.692	.9055	.9342	.832	-3.256
	-199.639	1.2145	1.2482	.875	-2.687
	-249.549	1.5277	1.5619	.99	-2.181
	-299.353	1.8453	1.8749	.859	-1.578
*	-349.345	2.1678	2.1992	.615	-.868
	-399.199	2.4962	2.5026	.183	-.252
	-449.476	2.8296	2.8161	-.391	.479
	-498.949	3.1669	3.1296	-1.081	1.192
	-548.886	3.50613	3.4435	-1.812	1.815
	-499.315	3.1681	3.13	-1.134	1.217
	-449.169	2.8311	2.8166	-.417	.511
	-399.285	2.4977	2.5027	.146	-.231
	-349.316	2.17	2.189	.549	-.865
	-299.432	1.8471	1.8753	.813	-1.494
	-249.578	1.5294	1.5621	.945	-2.082
	-199.653	1.2161	1.2483	.931	-2.564
	-149.715	.9067	.9344	.821	-2.943
	-99.8642	.6022	.621	.642	-3.317
	-49.9452	.2957	.3372	.333	-3.669
	49.8697	-.3109	-.3292	-.268	-2.957
	99.7399	-.6149	-.6337	-.541	-2.985
	149.586	-.931	-.947	-.75	-2.758
	199.496	-1.2296	-1.2637	-.899	-2.478
*	249.447	-1.5421	-1.5747	-.942	-2.278
	299.297	-1.8586	-1.888	-.85	-1.562
	349.171	-2.1802	-2.2015	-.615	-.969
	399.38	-2.5069	-2.5152	-.24	-.33
	449.538	-2.8389	-2.828	.385	.35
	498.897	-3.1748	-3.1426	.929	1.324
	548.806	-3.51313	-3.45644	1.64	1.643
	498.931	-3.1754	-3.1429	.941	1.337
	449.386	-2.8397	-2.8298	.334	.372
	399.075	-2.5081	-2.5152	-.224	-.282
	349.197	-2.1816	-2.2017	-.58	-.914
	299.335	-1.8638	-1.8881	-.806	-1.481
	249.376	-1.5439	-1.5742	-.878	-1.937
	199.5	-1.2313	-1.2637	-.852	-2.348
	149.615	-.9227	-.9472	-.749	-2.635
	99.6858	-.6162	-.6333	-.495	-2.733
	49.8528	-.3118	-.3031	-.238	-2.629

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 550

SCALE FACTOR (V/DEG/SEC): -6.28574E-03

BIAS (VOLTS) 9 -6.71413E-03

HYSTERESIS, NEG RATES (VDC): -2.47713E-03

HYSTERESIS, POS RATES (VDC): 1.77813E-03

NULL OFFSET (VDC): -7.84673E-03

TABLE 3.6.2-V

TEST ENGINEER [signature] 3-27-80

RATE SENSOR TEST PROGRAM

DATE..3-27-80..... RUN Post Acoustic B/L NADC 80081-60

TEMP..72°F...51%RH.. SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9431	.2883	.3212	.342	-4.127
	-99.8523	.5908	.6154	.651	-3.913
	-149.807	.8958	.9298	.902	-3.611
	-199.571	1.2035	1.2431	1.047	-3.148
	-249.451	1.5155	1.5571	1.1	-2.645
*	-299.419	1.8317	1.8716	1.057	-2.117
	-349.291	2.1534	2.1855	.852	-1.463
	-399.16	2.4805	2.4995	.501	-.754
	-449.069	2.8127	2.8136	.025	-.033
	-498.964	3.1491	3.1277	-.566	.681
	-548.933	3.4877	3.4423	-1.202	1.314
	-598.751	3.82568	3.75589	-1.848	1.852
	-548.923	3.4887	3.44224	-1.23	1.344
	-499.306	3.1506	3.128	-.598	.719
	-449.357	2.8147	2.8136	-.029	.339
	-399.201	2.4829	2.4997	.445	-.669
	-349.377	2.1559	2.1861	.799	-1.371
	-299.428	1.8344	1.8717	.988	-1.979
	-249.482	1.518	1.5573	1.041	-2.533
	-199.617	1.2059	1.2434	.992	-2.983
	-149.71	.8979	.9292	.831	-3.329
	-99.8337	.5924	.6153	.605	-3.635
	-49.9687	.289	.3014	.329	-3.948
	49.8714	-.3157	-.3271	-.303	-3.641
	99.7196	-.6188	-.6409	-.586	-3.526
	149.623	-.924	-.955	-.821	-3.294
	199.556	-1.2317	-1.2693	-.997	-2.997
	249.471	-1.5433	-1.5835	-1.066	-2.563
*	299.3	-1.8589	-1.8972	-1.013	-2.032
	349.178	-2.1799	-2.2112	-.828	-1.422
	399.107	-2.5058	-2.5255	-.522	-.784
	448.979	-2.837	-2.8394	-.364	-.086
	498.87	-3.1723	-3.1535	.5	.601
	548.806	-3.51031	-3.46774	1.127	1.232
	598.647	-3.84686	-3.78148	1.731	1.735
	548.813	-3.51104	-3.46779	1.145	1.252
	498.914	-3.1735	-3.1537	.523	.629
	449.002	-2.8384	-2.8396	-.229	-.339
	399.122	-2.5076	-2.5256	-.476	-.715
	349.275	-2.1817	-2.2118	-.797	-1.37
	299.324	-1.8639	-1.8974	-.964	-1.932
	249.469	-1.5451	-1.5835	-1.018	-2.449
	199.547	-1.2335	-1.2693	-.947	-2.846
	149.693	-.9255	-.9555	-.794	-3.181
	99.7484	-.6201	-.6411	-.556	-3.345
	49.847	-.3165	-.3269	-.277	-3.336

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 600

SCALE FACTOR (V/DEG/SEC): -6.29483E-03

BIAS (VOLTS) : -1.31749E-02

HYSTERESIS, NEG RATES (VDC): -2.66266E-03

HYSTERESIS, POS RATES (VDC): 2.02203E-03

NULL OFFSET (VDC): -1.28466E-02

TABLE 3.6.2-VI

TEST ENGINEER..... 3-27-80

RATE SENSOR TEST PROGRAM

DATE 3-27-80 RUN Post Acoustic B/L

TEMP. 72°F 51%RH SER# 381

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.947	.2883	.3058	.426	-5.549
	-99.8434	.5907	.6203	.721	-4.695
	-149.741	.8959	.9348	.951	-4.13
	-199.58	1.2037	1.249	1.136	-3.632
	-249.507	1.5154	1.5637	1.179	-3.371
	-299.406	1.8317	1.8783	1.137	-2.467
	-349.36	2.1534	2.1932	.971	-1.837
*	-399.182	2.48	2.5073	.665	-1.382
	-449.13	2.8125	2.8221	.235	-.34
	-499.211	3.149	3.1366	-.303	.394
	-548.893	3.48734	3.45107	-.885	1.248
	-598.822	3.8254	3.76581	-1.454	1.578
	-648.661	4.15885	4.07999	-1.925	1.929
	-598.723	3.82631	3.76506	-1.495	1.623
	-548.947	3.48937	3.45141	-.919	1.388
	-499.079	3.1539	3.137	-.34	.443
	-449.116	2.8149	2.822	.174	-.252
	-399.139	2.4827	2.5073	.631	-.979
	-349.302	2.1557	2.1928	.906	-1.686
	-299.389	1.8341	1.8782	1.077	-2.338
	-249.507	1.5175	1.5637	1.128	-2.938
	-199.619	1.2058	1.2493	1.06	-3.453
	-149.78	.8976	.9351	.914	-3.967
	-99.8354	.5923	.6202	.682	-4.443
	-49.9547	.289	.3058	.411	-5.349
	49.8739	-.3156	-.3235	-.193	-2.521
	99.7332	-.6184	-.6378	-.473	-3.881
	149.598	-.9238	-.9521	-.692	-3.887
	199.495	-1.2314	-1.2667	-.861	-2.836
	249.447	-1.543	-1.5816	-.942	-2.455
*	299.387	-1.8584	-1.8959	-.914	-1.936
	349.182	-2.1792	-2.2103	-.759	-1.413
	399.095	-2.505	-2.5249	-.487	-.792
	449.051	-2.836	-2.8398	-.393	-.135
	498.907	-3.1714	-3.1541	.423	.551
	548.633	-3.5095	-3.46879	.993	1.177
	598.754	-3.84584	-3.78343	1.522	1.652
	648.63	-3.99415	-4.09789	-2.532	-2.537
	598.831	-3.84683	-3.78378	1.539	1.67
	548.83	-3.51274	-3.46877	1.024	1.213
	498.943	-3.173	-3.1543	.455	.592
	449.046	-2.8379	-2.8398	-.047	-.067
	399.165	-2.5071	-2.5254	-.446	-.727
	349.289	-2.1813	-2.2104	-.712	-1.326
	299.303	-1.8635	-1.8959	-.862	-1.872
	249.435	-1.5448	-1.5815	-.895	-2.333
	199.539	-1.2332	-1.267	-.825	-2.687
	149.547	-.9254	-.9518	-.644	-2.8
	99.7281	-.6199	-.6378	-.435	-2.837
	49.8469	-.3165	-.3233	-.167	-2.172

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 653
SCALE FACTOR (V/DEG/SEC): -6.33381E-03
BIAS (VOLTS) : -9.13134E-03
HYSTERESIS, NEG RATES (VDC): -2.64645E-03
HYSTERESIS, POS RATES (VDC): 2.12765E-03
NULL OFFSET (VDC): -.012814

TEST ENGINEER [signature] 3-27-80

TABLE 3.6.2-VII

RATE SENSOR PROGRAM: OUTPUT DRIFT POST ACOUSTIC

DATE 3-28-80 RUN BASELINE

TEMP 72°F 50%RH SER# 355

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.797	.633486	6.31737E-03
99.799	.633281	6.31441E-03
99.8132	.633935	6.31536E-03
99.8295	.634545	6.31578E-03
199.597	1.21444	6.08438E-03
199.571	1.21503	6.08823E-03
199.599	1.21698	6.09737E-03
199.62	1.21822	6.10179E-03
299.403	1.8367	6.13455E-03
299.42	1.84345	6.15674E-03
299.423	1.8459	6.16529E-03
299.364	1.84766	6.17195E-03
399.196	2.48574	6.22686E-03
399.214	2.49577	6.25172E-03
399.236	2.49899	6.25991E-03
399.249	2.50121	6.26541E-03
499.338	3.16141	6.33501E-03
499.359	3.17348	6.35892E-03
499.369	3.17755	6.36883E-03
499.314	3.17981	6.37218E-03

FULL OFFSET (VDC): 2.27036E-03

Boyd W. Campbell 3-28-80

TABLE 3.6.2-VIII

RATE SENSOR PROGRAM: OUTPUT DRIFT NADC 80081-60

POST ACOUSTIC

DATE 3-28-80 RUN BASELINE

TEMP 72°F 50%RH SER# 373

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8197	.599355	6.344386E-03
99.8254	.601539	6.325616E-03
99.831	.602466	6.334866E-03
99.8365	.603056	6.340446E-03
199.618	1.21929	6.138813E-03
199.588	1.22421	6.133696E-03
199.605	1.22556	6.139946E-03
199.596	1.22655	6.145126E-03
299.364	1.86141	6.217876E-03
299.392	1.86836	6.243536E-03
299.419	1.87385	6.246336E-03
299.407	1.8715	6.253676E-03
399.196	2.53146	6.341376E-03
399.221	2.54137	6.365476E-03
399.217	2.54413	6.372796E-03
399.22	2.54638	6.377646E-03
499.973	3.23239	6.478196E-03
499.976	3.24514	6.503476E-03
499.918	3.24863	6.513046E-03
499.944	3.25469	6.513056E-03

NULL OFFSET (VDC): -6.427186E-03

Boyd W. Cumpton 3-28-80

TABLE 3.6.2-IX

RATE SENSOR PROGRAM: OUTPUT DRIFT — POST ACOUSTIC — NADC 80081-60

DATE 3-27-80 RUN BASELINE

TEMP 72°F 51%RH SER# 381

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8088	.58428	5.85281E-03
99.866	.586314	5.87101E-03
99.8614	.587033	5.87847E-03
99.8798	.587252	5.87963E-03
199.636	1.19446	5.96316E-03
199.688	1.19474	5.98551E-03
199.603	1.19587	5.99103E-03
199.589	1.19657	5.99513E-03
299.36	1.81238	6.05423E-03
299.394	1.81898	6.07552E-03
299.365	1.82084	6.08233E-03
299.427	1.82156	6.08349E-03
399.218	2.45457	6.14854E-03
399.179	2.46417	6.17317E-03
399.187	2.46667	6.17984E-03
399.188	2.46818	6.18299E-03
498.945	3.11943	6.25205E-03
499.003	3.13142	6.27535E-03
499.034	3.13445	6.28104E-03
499.038	3.13584	6.28376E-03

NULL OFFSET (VDC): -9.57715E-03

Boyd W. Camp Jr. 3-27-80

TABLE 3.6.2-X

POST ACOUSTIC TEST DATA SUMMARY

PARAMETER	S/N 355	S/N 373	S/N 381
FULL SCALE RATE (DEG/SECOND) AT ±2% LINEARITY ERROR	500	400	600
SCALE FACTOR (MV/DEG/SEC) AT BASELINE RATE	-6.30	-6.32	-6.29
BIAS (DEG/SECOND)	-0.53	+0.29	+1.07
HYSTERESIS CCW (DEG/SECOND)	+0.46	+0.28	+0.33
HYSTERESIS CW (DEG/SECOND)	-0.29	-0.24	-0.28
NULL OFFSET (DEG/SECOND)	-0.43	+0.89	+1.25
THRESHOLD (DEG/SECOND)	<0.10	<0.10	<0.10
RESOLUTION (DEG/SECOND)	<0.10	<0.10	<0.10
READYTIME (SECONDS) AVG. OF 5 RATES*	.061	.069	.071
DRIFT (DEG/SEC/MIN) AVG. OF 5 RATES*	+0.75	+0.75	+0.65

*100, 200, 300, 400, AND 500 DEGREES/SECOND

(SEE TABLE 3.6.3-II)

TABLE 3.6.3-I

POST ACOUSTIC DRIFT AND READYTIME

RATE (DEG/SEC)	OUTPUT DRIFT (DEG/SEC/MIN)			READYTIME (SECONDS)		
	355	373	381	355	373	381
100	+.82	+.76	+.57	.062	.070	.070
200	+.79	+.78	+.67	.060	070	.070
300	+.79	+.69	+.62	.060	.070	.070
400	+.58	+.76	+.73	.060	.068	.070
500	+.78	+.75	+.67	.062	.068	.075

TABLE 3.6.3-II

3.7 Vibration

3.7.1 Test Setup and Procedure

The Superjet rate sensors were individually subjected to a sinusoidal mechanical vibration along each of its mutually perpendicular axis as described in Figure B.2-1 in Appendix A, Part B of this report.

A test fixture was fabricated by the environmental lab to accept the hole pattern of the Superjet assembly. The test fixture was installed on a test cube that is part of the C-60 vibration test set. A control accelerometer was mounted on the test fixture to monitor the vibration input along the vertical axis of the test set. The unit was then mounted on the test fixture. The 2222B accelerometer was mounted on the unit along the sensitive axis using Eastman 910 adhesive. A resonance search from 10 Hz to 3000 Hz was conducted at 3 g rms to find the three most severe resonances. This part of the test deviates from the test plan which describes the search from 10 to 5000 Hz. The maximum frequency available at the Martin facility is 3000 Hz. MIL-STD-810C procedures defines 10 to 2000 Hz as the resonance search frequencies. After the severe resonances were determined, the unit was subjected to each resonance frequency for a period of 10 minutes at 5.2 g rms. The unit was then tested for the other axes in the same manner.

After the vibration test, the baseline test was performed for all three units. This is the final test of the program and the results were compared to the post-acoustic baseline test as described in Section 3.6.

3.7.2 Test Results

A dyna-monitor was used to fine tune the most severe frequencies for dwelling. The output accelerometer was installed on the fibre cap of the sensor for S/N 373, and 355 when vibrating the X-axis (jet axis). Upon removal of the accelerometer the fibre cap of S/N 355 separated from its bond joint. This caused concern and the accelerometer was installed on a block on the top of the sensor. This explains the differences of frequencies established along the X-axis. The accelerometer was continued to a hard mount on the sensor for the Y and Z axes. The frequencies for each axis and serial number that were searched at 3.0 g rms and occurred again at 5.2 g rms are shown in Table 3.7.2-I. Also shown is the accelerometer output in units of g (gravity)

AXIS	S/N 355		S/N 373		S/N 381	
	f Hz	g	f Hz	g	f Hz	g
X	605	7.0	605	5.0	605	4.0
	850	11.8	970	9.8	950	5.5
	1075	9.5	1125	7.8	2500	14.0
Y	620	7.0	605	7.2	605	7.0
	925	8.2	1000	12.0	1150	13.2
	1840	9.6	2300	15.0	2150	9.2
Z	575	7.0	1025	7.3	560	6.0
	975	9.0	2225	10.0	1100	6.2
	1950	14.0	2650	18.0	2350	18.0

TABLE 3.7.2-I
SEVERE RESONANCE FREQUENCIES

The results from the baseline tests are shown in Tables 3.7.2-II through 3.7.2-XI.

3.7.3 Data Evaluation

The Superjet rate sensor is virtually unaffected by vibration along the X and Z axes except for a small increase in null noise level.

However, when the rate sensor is subjected to a vibration along the Y-axis, (normal to jet-axis and input axis), a null shift occurs at a very high frequency. This was evident on S/N 355 and S/N 381, which occurred at 1995 Hz and 2150 Hz respectively, during the resonance search. A null shift also occurred on S/N 373, but this was detected only on the dwell sequence since a sweep was not performed. A sweep was not performed due to the use of a dynamometer to tune in the resonance frequency.

The worst case baseline data was reduced to yield the following:

1.	Full Scale Rate at $\pm$2% Linearity Error	500 $\pm$100 deg/sec
2.	Scale Factor	.00625 $\pm$.00002 V/deg/sec
3.	Bias	$\pm$2.19 deg/sec
4.	Hysteresis	$\pm$ .56 deg/sec
5.	Threshold	<0.10 deg/sec
6.	Resolution	<0.10 deg/sec
7.	Readytime	.080 seconds maximum
8.	Drift	+.76 deg/sec/min maximum
9.	Null Offset	$\pm$2.08 deg/sec

Readytime increased by 12% and the bias shifted by 104% on S/N 381. Since the other units did not change appreciably, the effects of vibration is predicted to be undamaging.

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 4-7-80 RUN POST VIBRATION BASELINE

TEMP. 72°F 50%RH SER# 355

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9437	.334	.3153	.362	-3.627
	-99.8135	.6375	.6284	.667	-3.337
	-149.739	.9139	.941	.866	-2.891
	-199.531	1.2032	1.2532	.957	-2.398
*	-249.467	1.5368	1.5665	.948	-1.9
	-299.331	1.8551	1.8788	.756	-1.263
	-349.159	2.1796	2.1914	.379	-.543
	-399.357	2.5099	2.5043	-.177	.222
	-449.895	2.8477	2.8174	-.965	1.375
	-499.849	3.191	3.13	-1.944	1.948
	-449.339	2.8487	2.8177	-.986	1.1
	-399.077	2.512	2.5244	-.248	.334
	-349.252	2.1826	2.192	.3	-.43
	-299.277	1.8585	1.8787	.645	-1.077
	-249.504	1.5433	1.5666	.84	-1.488
	-199.698	1.2264	1.2537	.871	-2.181
	-149.697	.9167	.9438	.767	-2.563
	-99.8195	.61	.6285	.589	-2.949
	-49.9538	.3053	.3154	.321	-3.239
	49.8514	-.3021	-.3134	-.264	-2.649
	99.7281	-.6062	-.6232	-.54	-2.738
*	149.593	-.9126	-.9358	-.74	-2.473
	199.452	-1.2217	-1.2484	-.854	-2.14
	249.347	-1.5346	-1.5613	-.852	-1.738
	299.205	-1.8515	-1.8739	-.715	-1.194
	349.118	-2.1742	-2.1868	-.434	-.578
	398.97	-2.5023	-2.4994	.093	.116
	448.897	-2.8368	-2.8125	.776	.864
	498.787	-3.1773	-3.1253	1.657	1.661
	448.899	-2.8376	-2.8125	.799	.89
	398.999	-2.5034	-2.4996	.12	.151
	349.121	-2.1756	-2.1869	-.36	-.516
	299.232	-1.8532	-1.8741	-.666	-1.113
	249.3	-1.5361	-1.561	-.794	-1.593
	199.51	-1.2233	-1.2488	-.812	-2.234
	149.55	-.9144	-.9355	-.673	-2.25
	99.7298	-.6079	-.6232	-.485	-2.434
	49.8273	-.3032	-.3136	-.237	-2.379

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 500

SCALE FACTOR (V/DEG/SEC): -6.27015E-03

BIAS (VOLTS) : 2.15551E-03

HYSTERESIS, NEG RATES (VDC): -3.52833E-03

HYSTERESIS, POS RATES (VDC): 1.83004E-03

NULL OFFSET (VDC): 1.98887E-03

TEST ENGINEER Boyd W. Campbell 4-7-80

READY

TABLE 3.7.2-II

RATE SENSOR TEST PROGRAM NADC 80081-60

POST VIBRATION

DATE. 4-7-80..... RUN. BASELINE.....

TEMP. 72°F. 50%RH... SER#...355.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.985	.3342	.3178	.393	-4.33
	-99.8117	.6379	.6321	.699	-3.852
	-149.68	.9143	.9467	.933	-3.427
*	-199.595	1.2838	1.2615	1.389	-3.021
	-249.466	1.5377	1.5761	1.149	-2.444
	-299.341	1.856	1.8907	1	-1.837
	-349.225	2.1834	2.2054	.719	-1.133
	-399.104	2.511	2.52	.259	-.357
	-449.933	2.848	2.8343	-.395	.484
	-499.859	3.1914	3.1493	-1.216	1.341
	-549.678	3.54347	3.46357	-2.217	2.222
	-499.868	3.1925	3.1493	-1.243	1.371
	-449.388	2.8498	2.8349	-.428	.524
	-399.118	2.5128	2.5201	.209	-.269
	-349.191	2.1827	2.2052	.647	-1.019
	-299.34	1.8588	1.8907	.99	-1.689
	-249.494	1.5406	1.5763	1.03	-2.27
	-199.549	1.2267	1.2612	.996	-2.744
	-149.656	.917	.9465	.851	-3.126
	-99.854	.6103	.6324	.636	-3.534
	-49.9843	.3055	.3178	.354	-3.892
	49.8545	-.3023	-.312	-.279	-3.081
	99.7518	-.6266	-.6267	-.58	-3.198
*	149.568	-.9127	-.9411	-.817	-3.035
	199.474	-1.222	-1.2558	-.973	-2.683
	249.373	-1.5351	-1.5705	-1.022	-2.254
	299.271	-1.8524	-1.8853	-.947	-1.74
	349.143	-2.1753	-2.1998	-.727	-1.114
	399.004	-2.5038	-2.5142	-.3	-.414
	448.892	-2.8382	-2.8291	.264	.323
	498.809	-3.1786	-3.1439	.998	1.131
	548.674	-3.50484	-3.45842	1.914	1.919
	498.775	-3.1794	-3.1437	1.329	1.135
	448.942	-2.8391	-2.8291	.227	.352
	399.046	-2.5051	-2.5146	-.275	-.379
	349.187	-2.1771	-2.2331	-.664	-1.246
	299.283	-1.8544	-1.8854	-.893	-1.641
	249.33	-1.5372	-1.5708	-.958	-2.209
	199.5	-1.2244	-1.2559	-.907	-2.5
	149.574	-.9153	-.941	-.74	-2.721
	99.7619	-.6084	-.6268	-.53	-2.923
	49.8775	-.3034	-.3121	-.251	-2.765

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 554

SCALE FACTOR (V/DEG/SEC): -6.3879[illegible]E-03

BIAS (VOLTS) : 2.5[illegible]E-03

HYSTERESIS, NEG RATES (VDC): -2.945[illegible]E-03

HYSTERESIS, POS RATES (VDC): 2.594[illegible]E-03

BULL OFFSET (VDC): 2.45735[illegible]-03

TEST ENGINEER..... 4-7-80

TABLE 3.7.2-III

RATE SENSOR TEST PROGRAM

POST VIBRATION

DATE 4-7-80 RUN BASELINE

TEMP 72°F 50%RH SER# 373

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.955	.2973	.3095	.488	-3.936
	-99.8151	.6023	.6209	.746	-2.989
	-149.788	.9107	.9327	.878	-2.345
*	-199.614	1.2231	1.2443	.85	-1.703
	-249.49	1.5411	1.5559	.591	-.947
	-299.223	1.8658	1.8665	.03	-.04
	-349.162	2.1975	2.1785	-.763	.974
	-399.128	2.5372	2.4936	-1.865	1.869
	-349.25	2.1983	2.179	-.773	.885
	-299.416	1.867	1.8677	.03	-.039
	-249.438	1.5429	1.5555	.544	-.809
	-199.597	1.225	1.2442	.77	-1.544
	-149.638	.9184	.9321	.78	-2.111
	-99.838	.604	.621	.682	-2.732
	-49.9777	.2984	.3096	.447	-3.577
	49.8457	-.3097	-.3139	-.169	-1.359
	99.767	-.6141	-.6258	-.466	-1.867
	149.559	-.9209	-.9368	-.635	-1.699
*	199.444	-1.231	-1.2484	-.697	-1.397
	249.422	-1.5457	-1.5606	-.595	-.953
	299.271	-1.8656	-1.872	-.253	-.338
	349.136	-2.1923	-2.1835	.355	.406
	399.053	-2.5262	-2.4953	1.238	1.241
	349.126	-2.1932	-2.1834	.393	.45
	299.261	-1.8666	-1.8719	-.213	-.284
	249.431	-1.547	-1.5605	-.54	-.867
	199.547	-1.2324	-1.248	-.667	-1.337
	149.603	-.9222	-.9371	-.594	-1.588
	99.789	-.6154	-.6259	-.422	-1.69
	49.8636	-.3136	-.314	-.14	-1.121

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 400

SCALE FACTOR (V/DEG/SEC): -6.24649E-03

BIAS (VOLTS) : -2.57981E-03

HYSTERESIS, NEG RATES (VDC): -1.88341E-03

HYSTERESIS, POS RATES (VDC): 1.37997E-03

NULL OFFSET (VDC): -5.85845E-03

TEST ENGINEER [signature] 4-7-80

READY

TABLE 3.7.2-IV

RATE SENSOR TEST PROGRAM NADC 80081-60

DATE 4-7-80 RUN POST VIBRATION BASELINE

TEMP. 72°F 50%RH SER# 373

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9503	.2962	.3148	.516	-4.666
	-99.8546	.6232	.6237	.834	-3.757
	-149.747	.9277	.9366	1.022	-3.372
*	-199.619	1.2191	1.2488	1.067	-2.485
	-249.448	1.5363	1.5617	.899	-1.622
	-299.377	1.8597	1.8747	.534	-.802
	-349.252	2.1906	2.1874	-.111	.143
	-399.126	2.509	2.5001	-1.321	1.151
	-448.945	2.8759	2.8125	-2.246	2.251
	-399.119	2.5298	2.5031	-1.452	1.156
	-349.291	2.1921	2.1877	-.156	.231
	-299.316	1.8618	1.8743	.445	-.668
	-249.433	1.5396	1.5616	.813	-1.467
	-199.61	1.2217	1.2498	.976	-2.2
	-149.72	.9298	.9364	.943	-2.833
	-99.8438	.6224	.6237	.753	-3.393
	-49.8614	.2976	.3139	.472	-4.252
	49.8643	-.3091	-.315	-.249	-1.885
	99.7399	-.6199	-.6277	-.53	-2.39
	149.625	-.9187	-.9405	-.771	-2.318
	199.439	-1.2281	-1.2528	-.977	-1.88
*	249.306	-1.542	-1.566	-.849	-1.532
	299.2	-1.8614	-1.8783	-.599	-.9
	349.099	-2.1977	-2.1918	-.124	-.16
	399.33	-2.521	-2.5341	.6	.677
	448.97	-2.8618	-2.8173	1.575	1.579
	399.243	-2.5217	-2.5343	.617	.696
	349.149	-2.1881	-2.1915	-.484	-.136
	299.231	-1.8633	-1.8785	-.537	-.838
	249.432	-1.5442	-1.5663	-.782	-1.41
	199.535	-1.2332	-1.2534	-.823	-1.855
	149.567	-.9289	-.9401	-.681	-2.35
	99.679	-.6146	-.6273	-.452	-2.341
	49.8435	-.3132	-.3148	-.164	-1.482

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 450

SCALE FACTOR (V/DEG/SEC): -6.26991E-03

BIAS (VOLTS) : -2.34913E-03

HYSTERESIS, NEG RATES (VDC): -2.535365E-03

HYSTERESIS, POS RATES (VDC): 2.177953E-03

NULL OFFSET (VDC): -6.14924E-03

TEST ENGINEER [signature] 4-7-80

READY

TABLE 3.7.2-V

RATE SENSOR TEST PROGRAM

POST VIBRATION

DATE 4-7-80 RUN BASELINE

TEMP. 72°F. 50%RH. SER# 381

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9807	.086	.0978	.345	-3.797
	-99.9178	.1668	.1838	.646	-3.556
*	-149.769	.268	.2798	.971	-3.199
	-199.591	1.1963	1.2331	.985	-2.714
	-249.446	1.5466	1.5411	1.336	-2.218
	-299.38	1.8216	1.8503	.995	-1.645
	-349.199	2.1413	2.1629	.63	-.998
	-399.394	2.4667	2.4731	.249	-.888
	-449.305	2.7978	2.7849	-.375	.46
	-499.847	3.133	3.2956	-1.398	1.833
	-548.663	3.47191	3.43614	-1.896	1.933
	-499.964	3.1339	3.0963	-1.496	1.838
	-449.371	2.7983	2.7853	-.398	.481
	-399.139	2.468	2.4741	.178	-.845
	-349.855	2.1431	2.1639	.588	-.985
	-299.345	1.8231	1.8591	.847	-1.555
	-249.403	1.5083	1.541	.952	-2.1
	-199.599	1.198	1.2334	.945	-2.624
	-149.705	.8919	.9184	.832	-2.948
	-99.8383	.5883	.6304	.588	-3.941
	-49.9355	.0867	.0976	.317	-3.491
	49.881	-.3146	-.3246	-.299	-3.22
	99.7721	-.6158	-.6359	-.577	-3.18
	149.569	-.9192	-.9459	-.75	-2.869
	199.538	-1.2252	-1.2572	-.933	-2.573
*	249.43	-1.535	-1.5693	-.971	-2.142
	299.354	-1.849	-1.8795	-.89	-1.635
	349.138	-2.1686	-2.1898	-.62	-.976
	399.37	-2.4987	-2.5211	-.246	-.339
	448.946	-2.8004	-2.8119	.338	.377
	498.813	-3.1563	-3.1007	.978	1.378
	548.711	-3.49387	-3.43368	1.756	1.76
	498.843	-3.1571	-3.1228	.997	1.399
	449.346	-2.8233	-2.8163	.321	.393
	399.343	-2.4937	-2.5319	-.81	-.89
	349.19	-2.1697	-2.1931	-.596	-.939
	299.315	-1.8535	-1.8793	-.838	-1.54
	249.464	-1.5367	-1.5686	-.928	-2.345
	199.539	-1.2268	-1.2574	-.891	-2.455
	149.643	-.9268	-.9464	-.745	-2.739
	99.6858	-.6171	-.635	-.521	-2.877
	49.9156	-.3155	-.3248	-.27	-2.976

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 554

SCALE FACTOR (V/DEG/SEC): -6.232889E-03

BIAS (VOLTS) : -1.367966E-02

HYSTERESIS, NEG RATES (VDC): -1.955636E-03

HYSTERESIS, POS RATES (VDC): 1.737488E-03

NULL OFFSET (VDC): -1.293995E-02

3.7.2-VI

TEST ENGINEER [signature] 4-7-80

RATE SENSOR TEST PROGRAM

DATE...4-7-80..... RUN...POST VIBRATION BASELINE..... NADC 80081-60

TEMP.72°F....50%RH. SER#....381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9386	.886	.2991	.348	-4.175
	-99.8354	.5868	.6116	.661	-3.97
	-149.805	.8699	.9246	.923	-3.698
	-199.571	1.1961	1.2363	1.071	-3.221
	-249.411	1.5063	1.5485	1.123	-2.722
	-299.375	1.8209	1.8615	1.08	-2.164
*	-349.231	2.1407	2.1738	.88	-1.511
	-399.186	2.466	2.4867	.55	-.827
	-449.082	2.7971	2.7992	.057	-.376
	-498.91	3.1325	3.1113	-.563	.678
	-548.747	3.47083	3.42354	-1.258	1.376
	-598.644	3.80909	3.73600	-1.943	1.947
	-548.795	3.47181	3.42384	-1.276	1.395
	-498.849	3.1342	3.1109	-.62	.745
	-448.995	2.7993	2.7987	-.016	.321
	-399.077	2.4682	2.486	.472	-.71
	-349.229	2.1434	2.1736	.806	-1.385
	-299.414	1.8235	1.8617	1.018	-2.04
	-249.492	1.5087	1.549	1.074	-2.584
	-199.546	1.1983	1.2362	1.008	-3.332
	-149.67	.8921	.9238	.843	-3.379
	-99.8404	.5885	.6117	.617	-3.726
	-49.9459	.2869	.2991	.326	-3.92
	49.8716	-.3147	-.3261	-.388	-3.638
	99.7298	-.6161	-.6304	-.594	-3.576
*	149.611	-.9193	-.9548	-.839	-3.366
	199.532	-1.2255	-1.2635	-1.313	-3.345
	249.464	-1.5354	-1.5763	-1.089	-2.618
	299.29	-1.8493	-1.8884	-1.04	-2.384
	349.209	-2.1685	-2.2011	-.866	-1.488
	399.068	-2.4927	-2.5134	-.55	-.827
	448.987	-2.8225	-2.826	-.093	-.105
	498.833	-3.1568	-3.1383	.494	.594
	548.731	-3.49442	-3.45077	1.161	1.27
	598.615	-3.83134	-3.76323	1.812	1.816
	548.789	-3.49535	-3.45113	1.176	1.286
	498.831	-3.1581	-3.1383	.527	.634
	449.011	-2.8241	-2.8262	-.056	-.074
	399.075	-2.4945	-2.5134	-.502	-.755
	349.143	-2.1703	-2.2007	-.807	-1.386
	299.329	-1.8512	-1.8806	-.996	-1.997
	249.439	-1.5373	-1.5761	-1.233	-2.485
	199.491	-1.2273	-1.2633	-.958	-2.88
	149.576	-.9213	-.9536	-.781	-3.131
	99.7687	-.6175	-.6306	-.563	-3.306
	49.8479	-.3158	-.3259	-.271	-3.264

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 600

SCALE FACTOR (V/DEG/SEC): -6.26373E-03

BIAS (VOLTS) : -1.37173E-02

HYSTERESIS, NEG RATES (VDC): -2.63329E-03

HYSTERESIS, POS RATES (VDC): 1.90114E-03

FULL RESET (VDC): -1.09701E-02

3.7.2-VII

TEST ENGINEER Boyd W. Cary Jr 4-7-80

RATE SENSOR TEST PROGRAM **POST VIBRATION**

DATE...4-7-80..... RUN...**BASELINE**.....

TEMP 72°F....50%RH.. SER#...381.....

	RATE (DEG/SEC)	V OUT (VDC)	V CALC (VDC)	% FS	% IDEAL
	-49.9396	.2853	.3024	.42	-5.469
	-99.81	.5853	.6149	.726	-4.729
	-149.744	.8881	.9278	.975	-4.231
	-199.544	1.1934	1.2399	1.142	-3.72
	-249.45	1.503	1.5526	1.217	-3.171
*	-299.368	1.8168	1.8654	1.195	-2.594
	-349.23	2.1363	2.1779	1.021	-1.9
	-399.147	2.4611	2.4907	.726	-1.188
	-449.332	2.7914	2.8033	.292	-.422
	-498.9	3.1263	3.1158	-.26	.338
	-548.812	3.46414	3.42858	-.873	1.034
	-598.644	3.80002	3.74284	-1.587	1.636
	-648.59	4.13696	4.05382	-2.041	2.346
	-598.649	3.80356	3.74288	-1.539	1.671
	-548.918	3.46625	3.42924	-.989	1.376
	-498.893	3.1286	3.1157	-.322	.42
	-449.208	2.7943	2.8031	.216	-.313
	-399.393	2.4642	2.4903	.641	-1.344
	-349.279	2.1395	2.1782	.949	-1.766
	-299.279	1.82	1.8649	1.1	-2.389
	-249.543	1.506	1.5532	1.159	-3.02
	-199.59	1.1962	1.2402	1.079	-3.515
	-149.648	.8905	.9272	.908	-3.918
	-99.8286	.5873	.615	.68	-4.431
	-49.9489	.2863	.3025	.396	-5.153
	49.8914	-.3142	-.3032	-.22	-2.86
	99.7315	-.6149	-.6355	-.506	-3.296
	149.699	-.918	-.9486	-.752	-3.263
	199.567	-1.2035	-1.2611	-.923	-3.038
	249.369	-1.5328	-1.5732	-.991	-2.584
*	299.298	-1.8463	-1.8861	-.975	-2.118
	349.822	-2.1658	-2.1989	-.827	-1.539
	399.885	-2.489	-2.5114	-.55	-.895
	449.331	-2.8139	-2.8243	-.135	-.195
	498.87	-3.1523	-3.1367	.383	.5
	548.686	-3.48972	-3.44877	1.025	1.191
	598.721	-3.8264	-3.76231	1.573	1.738
	648.498	-3.98751	-4.37423	-2.129	-2.134
	598.667	-3.82694	-3.76197	1.595	1.732
	548.792	-3.49372	-3.44944	1.313	1.2
	498.824	-3.154	-3.1362	.436	.568
	449	-2.8235	-2.8242	-.291	-.131
	399.366	-2.4914	-2.5113	-.488	-.794
	349.237	-2.168	-2.1988	-.756	-1.437
	299.292	-1.8492	-1.886	-.935	-1.965
	249.431	-1.5354	-1.5734	-.954	-2.433
	199.503	-1.2258	-1.2607	-.858	-2.795
	149.733	-.92	-.9486	-.723	-3.052
	99.7695	-.6166	-.6354	-.462	-3.029
	49.87	-.3153	-.323	-.191	-2.493

TEST SUMMARY

FULL SCALE RATE (DEG/SEC): 650

SCALE FACTOR (V/DEG/SEC): -6.26639E-03

BIAS (VOLTS) : -1.35440E-02

HYSTERESIS, NEG RATES (VDC): -3.23302E-03

HYSTERESIS, POS RATES (VDC): 2.64352E-03

NULL OFFSET (VDC): -1.31849E-02

TEST ENGINEER..... 4-7-80

TABLE 3.7.2-VIII

RATE SENSOR PROGRAM : OUTPUT DRIFT
POST VIBRATION NADC 80081-60

DATE..4-7-80..... RUN BASELINE.....

TEMP..72°F...50%RH.. SER#.355.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8345	.623388	6.243368E-03
99.8457	.625652	6.265888E-03
99.8478	.626267	6.271955E-03
99.8376	.626618	.006376
199.596	1.21384	6.081428E-03
199.611	1.21663	6.105435E-03
199.622	1.22021	6.118668E-03
199.6	1.22098	6.117142E-03
299.397	1.84496	6.148888E-03
299.386	1.84771	6.171668E-03
299.458	1.85352	6.179588E-03
299.461	1.85231	6.185338E-03
399.2	2.49331	6.237498E-03
399.184	2.49831	6.261368E-03
399.198	2.50242	6.268618E-03
399.192	2.50452	6.273978E-03
499.331	3.165	6.340328E-03
499.385	3.1778	6.368038E-03
499.365	3.18113	6.374188E-03
499.366	3.18396	6.379238E-03

NULL OFFSET (VDC): 2.45548E-03

Boyd W. Carey Jr
4-7-80

TABLE 3.7.2-IX

RATE SENSOR PROGRAM: OUTPUT DRIFT

DATE..4-7-80..... RUN..POST VIBRATION BASELINE..... NADC 80081-60

TEMP..72°F 50%RH..... SER#...373.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	TEMP (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.[illegible]	.63146	6.323[illegible]E-03
99.[illegible]35	.63357[illegible]	6.34573E-03
99.[illegible]46	.63435[illegible]	6.3553[illegible]E-03
99.83	.63471[illegible]	6.35744E-03
199.[illegible]7	1.[illegible]57	6.11484E-03
199.[illegible]8	1.[illegible]488	6.13[illegible]8E-03
199.[illegible]19	1.[illegible]8[illegible]	6.14167E-03
199.688	1.[illegible]788	6.14774E-03
299.43	1.86054	6.21362E-03
299.441	1.86709	6.23526E-03
299.407	1.86902	6.24041E-03
299.441	1.87333	6.246[illegible]E-03
399.[illegible]31	2.5[illegible]87	6.3344[illegible]E-03
399.[illegible]21	2.53[illegible]13	6.35771E-03
399.19	2.54[illegible]77	6.364[illegible]E-03
399.19[illegible]	2.54[illegible]22	6.36[illegible]1E-03
499.[illegible]57	3.[illegible]597	6.465[illegible]E-03
499.[illegible]	3.[illegible]8[illegible]	6.48[illegible]5[illegible]E-03
499.[illegible]	3.84146	6.49[illegible]3[illegible]E-03
499.[illegible]	3.84395	6.54[illegible]6E-03

FULL OFFSET (VDC): 4.56691[illegible]E-[illegible]

Boyd W. Cumpton
4-7-80

TABLE 3.7.2-X

RATE SENSOR PROGRAM: OUTPUT DRIFT

POST VIBRATION NADC 80081-60

DATE...4-7-80..... RUN...BASELINE.....

TEMP.72°F...50%RH... SER#...381.....

OUTPUT DRIFT IN 15 SEC INTERVALS

RATE (DEG/SEC)	MEAN (VDC)	SCALE FACTOR (VOLTS/DEG/SEC)
99.8345	.584426	5.853958-03
99.8625	.586381	5.871548-03
99.8944	.586943	5.875048-03
99.8788	.587049	5.877658-03
199.64	1.19346	5.963338-03
199.632	1.19457	5.993008-03
199.631	1.19552	5.998648-03
199.639	1.19611	5.991358-03
299.45	1.8133	6.044518-03
299.449	1.81712	6.068198-03
299.396	1.81874	6.074718-03
299.414	1.81985	6.075358-03
399.212	2.45169	6.141838-03
399.224	2.46121	6.164998-03
399.220	2.46363	.036171
399.234	2.46515	6.174758-03
499.982	3.11433	6.243768-03
499.943	3.12579	6.264468-03
499.994	3.1285	6.269648-03
499	3.1336	6.273758-03

PULL OFFSET (VDC): -1.345318-02

Boyd W. Cary
4-7-80

TABLE 3.7.2-XI

POST VIBRATION TEST DATA SUMMARY

PARAMETER	S/N 355	S/N 373	S/N 381
FULL SCALE RATE (DEG/SECOND) AT ±2% LINEARITY ERROR	500	400	600
SCALE FACTOR (MV/DEG/SEC) AT BASELINE RATE	-6.27	-6.25	-6.23
BIAS (DEG/SECOND)	-0.34	+0.41	+2.19
HYSTERESIS CCW (DEG/SECOND)	+0.56	+0.30	+0.31
HYSTERESIS CW (DEG/SECOND)	-0.29	-0.22	-0.27
NULL OFFSET (DEG/SECOND)	-0.32	+0.94	+2.08
THRESHOLD (DEG/SECOND)	<0.10	<0.10	<0.10
RESOLUTION (DEG/SECOND)	<0.10	<0.10	<0.10
READYTIME (SECONDS) AVG. OF 5 RATES*	.070	.070	.080
DRIFT (DEG/SEC/MIN) AVG. OF 5 RATES*	+0.76	+0.72	+0.63

*100, 200, 300, 400 AND 500 DEGREES/SECOND.
(See Table 3.7.3-II)

TABLE 3.7.3-I

POST VIBRATION DRIFT AND READYTIME

RATE (DEG/SEC)	OUTPUT DRIFT (DEG/SEC/MIN)			READYTIME (SECONDS)		
	355	373	381	355	373	381
100	+.70	+.72	+.51	.072	.072	.085
200	+.76	+.70	+.61	.070	.072	.078
300	+.77	+.69	+.64	.068	.068	.075
400	+.78	+.72	+.70	.068	.070	.075
500	+.80	+.75	+.70	.072	.070	.090

TABLE 3.7.3-II

4.0 CONCLUSIONS AND RECOMMENDATIONS

The data collected and evaluated produced the following information on the 3 Superjet Angular Rate Sensors tested:

SUPERJET TEST DATA (Worst Case)

1.	Full Scale Rate at ±2% Linearity	500 ±100 deg/sec
2.	Scale Factor	.0062 ±.0002 V/deg/sec
3.	Null Bias (calculated)	±2 deg/sec
4.	Hysteresis	±0.6 deg/sec
5.	Threshold	<0.1 deg/sec
6.	Resolution	<0.1 deg/sec
7.	Readytime	80 milliseconds maximum
8.	Drift	+0.76 deg/sec/min
9.	Null Offset (measured)	±2 deg/sec
10.	G-Sensitivity	1.68 deg/sec/g maximum
11.	High Temperature Tested	+165°F
12.	Low Temperature Tested	-30°F
13.	Sensitivity to Jerk	Negligible
14.	Acoustic Sensitivity	Negligible
15.	Vibration Sensitivity	±2 deg/sec at approx. 2,000 Hz

The low temperature environment -30°F changes the scale factor by -10%. The reduction of the scale factor by 10% shifts the least squares fit straight line out of the ±2% linearity limits of the baseline performance, (See Figure 3.4.2-1).

The Superjet rate sensor/electronic package needs to be better temperature compensated for the requirements of the Maximum Performance Escape System.

It is difficult to determine the impact of a (worst case) 1.68 deg/second/g G-sensitivity effects of the Superjet, without a clearer definition of the MPES requirements. A conceivable 10 g environment would generate a 10 degree/second error.

Considering the results of this test program, it appears that the Superjet angular rate sensor is a viable candidate for the Maximum Performance Escape System. Additional testing should be performed to verify the unexpected high G-sensitivity.

LIST OF TERMS

ACOUSTIC SENSITIVITY:

Acoustic Sensitivity is the effect of acoustic vibration on an operating sensor (output change vs. frequency) and the shift in performance parameters after a known acoustic environment.

BIAS:

Bias is the null or zero offset evaluated as the output at zero input as calculated using the method of least squares to input-output data obtained by varying the input cyclically over the input span. This excludes outputs due to hysteresis and acceleration.

DRIFT:

Drift is the change in output at a given rate over a specified period of time (degrees/second/minute).

G-SENSITIVITY:

G-Sensitivity is the effect of acceleration on the output of the sensor. (degrees/second/g)

HYSTERESIS:

Hysteresis is the difference between output signals for increasing and decreasing inputs at that input for which the difference is maximum, measured after cycling through the input span (degrees/second).

JERK:

The constant rate of change of acceleration.

NON-LINEARITY:

Non-linearity is a term which describes the systematic deviations from the least squares straight line for input-output relationships which nominally can be represented by a linear equation. In this case non-linearity is $\pm$2% full scale.

NULL OFFSET:

Null offset is the sensor output when the input rate is zero, generally expressed as an equivalent input rate. It excludes outputs due to hysteresis and acceleration (degrees/second).

READYTIME:

Readytime is the time required for the sensor to measure 95% of its steady-state output, at all rates, without any electronic warmup.

RELIABILITY:

Reliability is the probability that a sensor will meet specified performance requirements under specified environmental conditions throughout a specified operating or storage life.

RESOLUTION:

Resolution is the largest value of the minimum change in input, for inputs greater than the threshold, which produces a change in output equal to some specified percentage (at least fifty percent) of the change in output expected using the nominal scale factor (degrees/second).

SCALE FACTOR:

Scale factor is the ratio of change in output to a change in the input intended to be measured. Scale factor is generally evaluated as the slope or the straight line that can be fitted by the method of least squares to input-output data obtained by varying the input cyclically over the input span (volts/degree/second).

THRESHOLD:

Threshold is the largest absolute value of the minimum input that produces an output equal to some specified percentage (at least fifty percent) of the output expected using the nominal scale factor (degree/second).

VIBRATION SENSITIVITY:

Vibration sensitivity is the effect of vibration on an operating sensor (output change vs. frequency) and the shift in performance parameters after a known vibration environment.

APPENDIX A

Introduction

This test procedure outlines the details and order of events to evaluate the performance of Hamilton-Standard's "SUPERJET" Rate Sensor for application to a Navy Air Development Center (NADC) Program. This procedure is in accordance with "Test Plan, for Performance Verification Tests, on the SUPER-JET Angular Rate Sensor, Contract No. DAAK40-79-D-0017, November, 1979", prepared by Jerome C. Salmons. The test plan has been approved by NADC as of January 11, 1980.

A. Baseline Test

A.1 Parameters to be measured are:

Input Voltage (Volts)
Input Current (Amps)
Full Scale Range at 2% Linearity (Degrees/Seconds)
Hysteresis (VDC)
Threshold (Degrees/Seconds)
Resolution (Degrees/Seconds)
Output Drift (Degrees/Seconds/Minutes)
Ready Time (Seconds)
Null Offset (VDC)

A.2 Test Setup

The baseline tests are conducted at $77^{o}F \pm 10^{o}F$ and less than 90% relative humidity.

The equipment used for baseline performance was:

Genisco 1100-2 Rate Table & Controller
BWC032580-001 Test Plate
BWC032580-002 Test Plate
8"X8"X8" Cube Test Fixture
Honeywell 1858 Visicorder
Hewlett Packard 9500A Test Set :
- 1 - HP 2116C Computer
- 2 - 50 Volt Power Supplies
- 2 - 100 Volt Programmable Power Supplies
- 5 - 40 Volt Power Supplies
- 1 - Programmable Counter
- 1 - Oscilloscope
- 1 - Volt - Ohmmeter
- Modular Switch Panel

A test schematic is shown in Figure A.2-1.

A.3 Test Procedure

1. Install test plate BWC032580-001 to top of Genisco 1100-2 Rate Table. Insure that "connector" stamped on plate is near connector located on rate table.

2. Install test plate BWC032580-002 onto 8"X8"X8" cube test fixture.

3. Install Superjet sensor on test plate BWC032580-002 and install cube on table so that sensor is located on the rate table centerline. (Input axis parallel to rate table axis.)

4. Connect wires on rate table to sensor.

5. Load "scale factor" program in 9500A computer test set and turn on rate table controller.

6. Engage Switch 1 on computer switch panel, (See Figure A.3-1).

7. If hysteresis measurement at each rate increment is desired, engage Switch 14.

8. To abort test Switch 15 should be engaged.

9. Run program.

10. Check voltage and current requirements on printout. The values shall be:

Voltage		+15.0V $\pm$0.5V -15.0V $\pm$0.5V
Current -	Positive	85.0 $\pm$5.0 ma
	Negative	11.0 $\pm$1.0 ma

11. Check temperature reading (if high or low temperature extremes) and null offset.

12. Disengage Switch 1 on computer switchboard.

13. Insert maximum rate desired and rate increment, (degrees/second, example: 500, 50), into computer.

14. Make test run.

15. Obtain data printout. Check test summary:

    *Full Scale Rate
    Scale Factor
    Bias
    *Hysteresis, Negative Rates
    *Hysteresis, Positive Rates
    *Null Offset**

*Determined by least squares fit.
**Added after first run of baseline test.

16. Note temperature, relative humidity, date, and barometric pressure.

17. Check percent of full scale linearity error to be less than $\pm$2%.

18. Rerun program at new maximum rate until linearity error exceeds $\pm$2%.

19. For this program rate incrememts have been set at 50 degrees/second.

20. Repeat Steps 1 thru 19 for other Rate Sensor units.

21. Load "Output Drift/Ready Time/Threshold/Resolution" program in the 9500A Computer Test Set and turn on Rate Table Controller.

22. Connect the Honeywell 1858 Visicorder to the patch panel on the Hewlett Packard 9500A Test Set. The remote drive on the Visicorder is connected to D21 and D22 on the patch panel. Set time lines to .1 seconds and chart speed to 8 in/second. Using a channel on the Visicorder with a sensitivity of 500 millivolts per division, connect the signal line to L27 on the patch panel. The computer is programmed to run recorder for 250 milliseconds, turn on the sensor and measure output for 750 milliseconds, for readytime measurements.

23. Run program.

24. When bells ring, set sensitivity on recorder to 100 mv/division for 100 degree/sec. rate. This must be done within two minutes after sounding bell.

25. When bells ring, set sensitivity to 200 mv/division for 200 degree/second rate - two minute wait.

26. When bells ring, set sensitivity to 500 mv/div. This will be setting for 300, 400, and 500 degrees/second rates.

27. Data printout:

    Output Drift
    Null Offset

28. Repeat Steps 23 thru 27 for other units.

29. Engage switch 1 on computer switchboard and run program.

30. Set sensitivity of recorder to 5 MV full scale. It may be required to use an external power generator to offset the null offset voltage of any sensor.

31. Set recorder drive to manual and set at .8 in./sec. chart speed with time lines at 10 second intervals.

32. Operate the rate table controller manually from zero degree/second to 1.0 degree/second in 0.1 degree/second increments. Allow each increment to run 1 second minimum. (Threshold test, ref.).

33. Operate the rate table controller manually from 5.0 to 6.0 degrees/second in 0.1 degrees/second increment. Allow each increment to run 1 second minimum. (Resolution test, ref.).

34. Repeat Steps 30 thru 33 for other units.

35. Stop program.

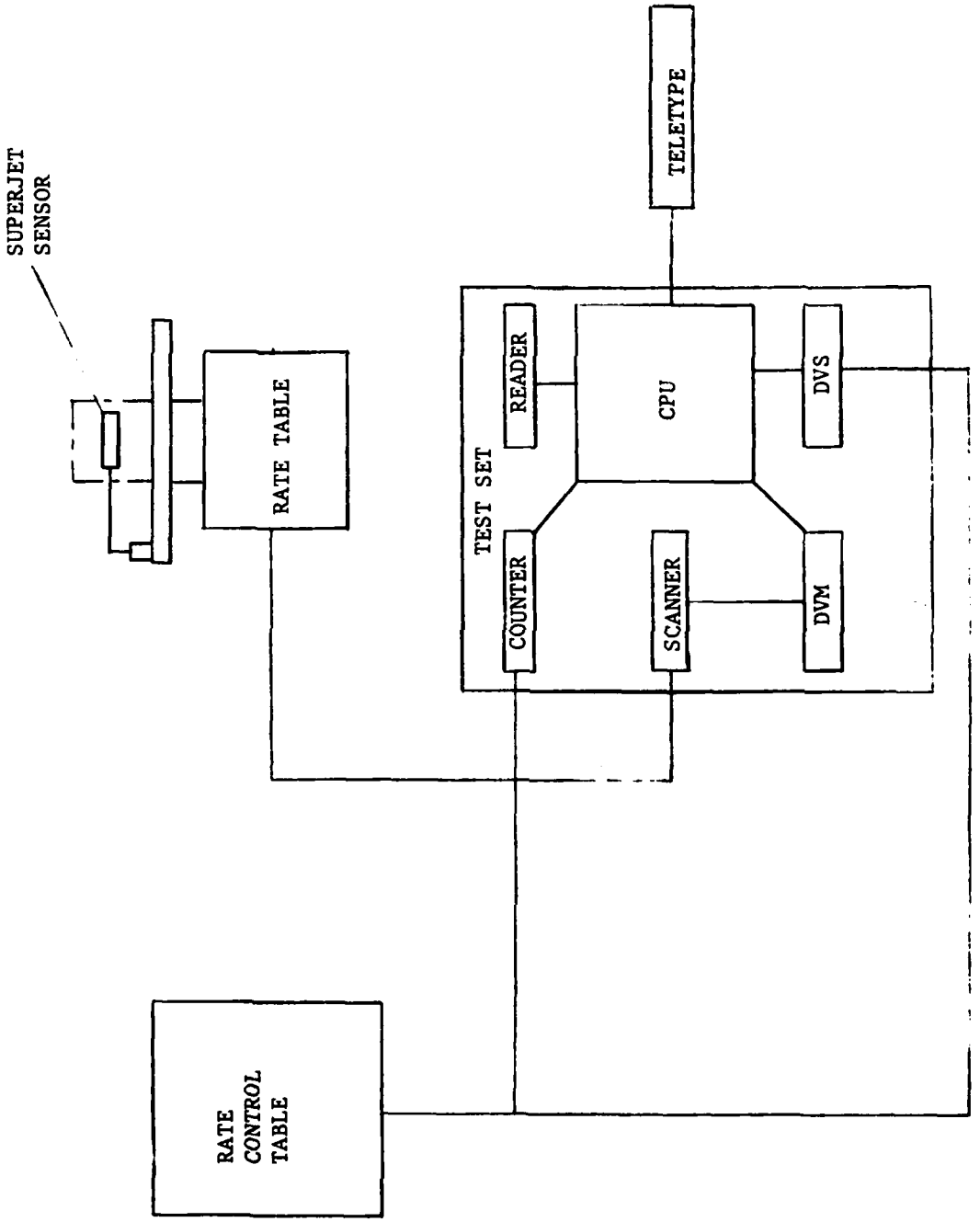


FIGURE A.2-1

BASELINE TEST SCHEMATIC

APPENDIX A - PART B

B. ACCELERATION SENSITIVITY

B.1 Parameters to be measured:

Output vs. Acceleration (in units of gravity g)
Null Offsets

B.2 Test Setup

The acceleration test was conducted at 77°F ±10°F and less than 90% relative humidity.

The equipment used for the acceleration test was:

Hewlett Packard 9500A Test Set
Genisco G1100-2 Rate Table and Controller
8"X8"C8" Test Cube
BWC032580-001 Test Plate
BWC032580-002 Test Plate
BWC032580-003 Arm
BWC032580-004 Angle (used for acceleration of Z axis)
BWC032580-005 Plate (used for acceleration of X and Y axis)

The test setup schematic is shown in Figure B.2-1, which is the baseline test schematic. *Axis orientation is shown in Figure B.2-1.*

B.3 Test Procedure

The acceleration test was performed by the following steps:

1. Install test plate BWC032580-001 to top of Genisco 1100-2 rate table. Insure that "connector" is stamped on plate near connector located on rate table.

2. Install test plate BWC032580-002 into 8"X8"X8" cube test fixture.

3. Install Superjet sensor on test plate BWC032580-002 insuring that sensor is located on the rate table centerline.

   Mount cube test fixture as follows:

AXIS ACCELERATED	HOLE PATTERN USED ON BWC032580-001 TEST PLATE
X	1
Y	1
Z	3 (jet axis down)

Check to see that sensor centerline is on rate table centerline.

4. Connect wires on rate table to sensor.

5. Load "scale factor" program in 9500A computer test set and turn on rate table controller.

6. Disengage switch 1 on computer switchboard.

7. Engage switch 14.

8. To abort test switch 15 should be engaged.

9. Run program.

10. Input maximum rate of 500 degrees per second and 50 degrees per second rate increment. i.e. 500, 50.

11. Test run.

12. Data printout.

13. Note temperature, relative humidity, date, and barometric pressure.

14. Repeat steps 3 through 13 for each axis and unit, (should be 6 runs for 3 units since X and Y axis runs are identical).

15. Remove test plates and test cube from rate table.

16. Attach BWC032580-003 arms to rate table.

17. Attach units to either BWC032580-004 angle or BWC032580-005 plate depending on which axis is accelerated (make sure that both sides are identical for maintaining proper rate table balance).

18. Connect electrical pigtail to one of the units.

19. Run program.

20. Input maximum rate of 500 degrees/second.

21. Test run.

22. Data printout.

23. Note temperature, relative humidity, date and barometric pressure.

24. Repeat steps 17 through 23 for all configurations.

25. End of testing.

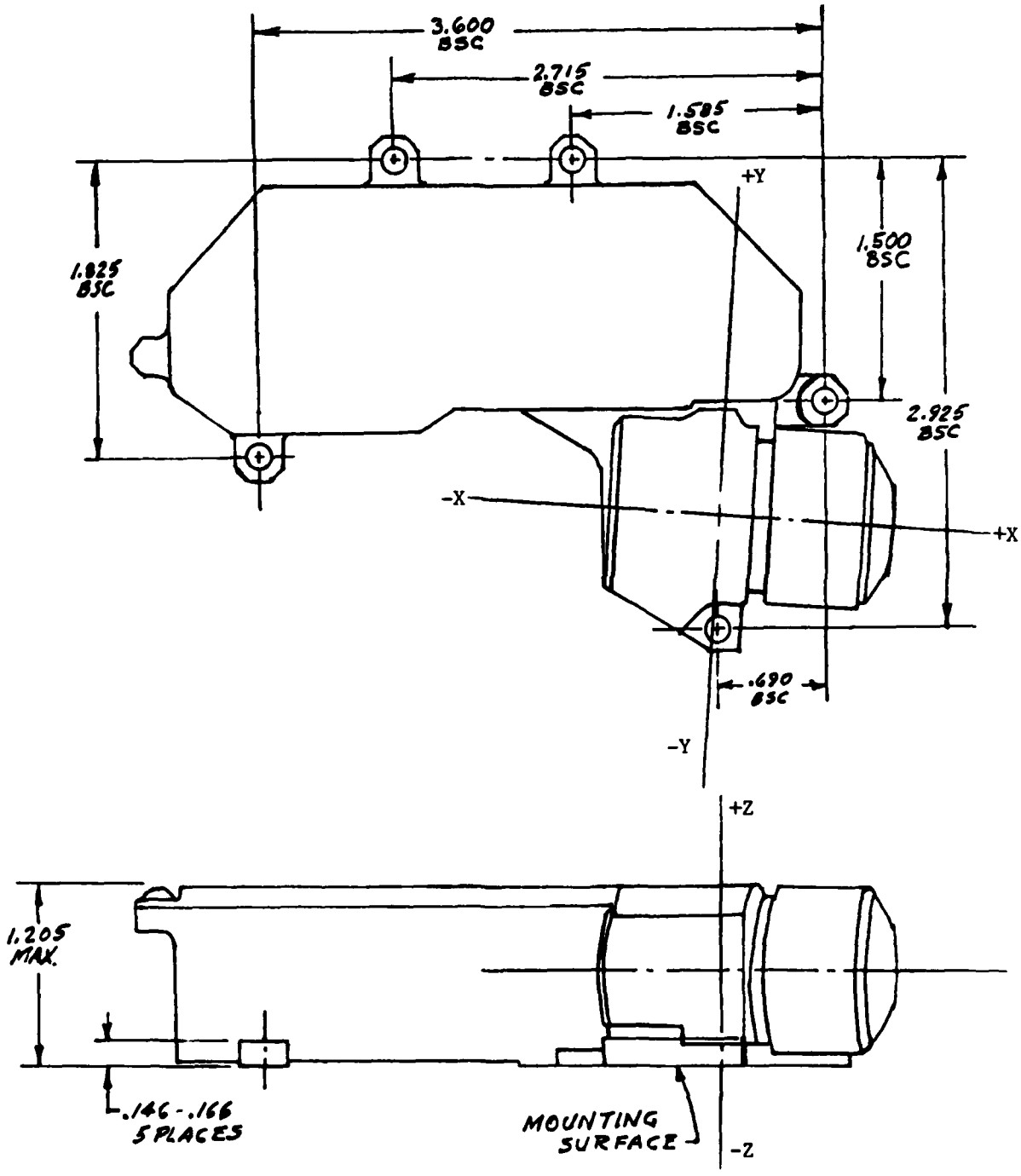


FIGURE B.2-1

SENSOR ORIENTATION

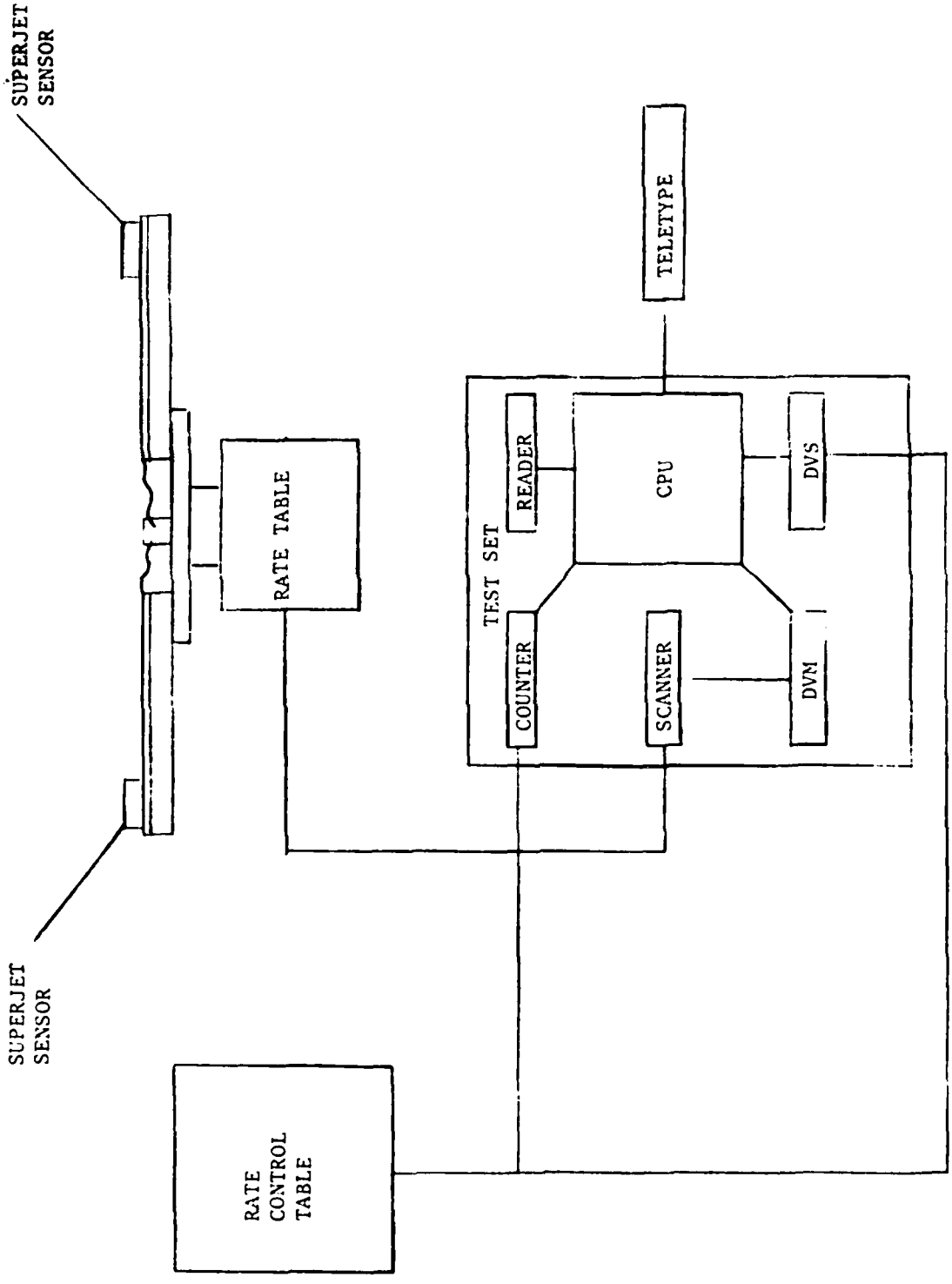


FIGURE B.2-2

ACCELERATION TEST SCHEMATIC

APPENDIX A - PART C

C. TEMPERATURE SENSITIVITY

C.1 Parameters to be measured are:

Input Voltage
Input Current
Full Scale Range at ±2% Linearity
Hysteresis
Threshold
Resolution
Output Drift
Readytime
Null Offset

C.2 Test Setup

The temperature sensitivity tests were conducted at -30°F ±5°F and +165°F ±5°F. The equipment used for this test was:

Hewlett Packard 9500A Test Set
Genisco G1100-2 Rate Table and Controller
8"X8"X8" Test Cube
BWC032580-001 Test Plate
BWC032580-002 Test Plate
Martin Marietta Temperature Controller
Fenwal UUT 45J1 Thermistor
Martin Marietta Environmental Chamber (Portable)
Honeywell 1858 Visicorder
Liquid Nitrogen Bottle
Iron-constantine Thermocouple Wire

C.3 Test Procedure

This procedure may be used for both hot and cold temperature testing. The only difference is the external setup. Figure C.3-1 shows the test schematic for the high temperature testing. The cold temperature test schematic is shown in Figure C.3-2. The test procedure for either hot or cold environments is as follows:

1. Bring test unit to temperature and soak for 45 minutes.
2. Load "scale factor" program in 9500A computer test set and turn on rate table controller.
3. Engage switch 1 on computer switchboard.
4. If hysteresis at each rate is desired, engage switch 14.
5. To abort test switch 15 should be engaged.

6. Run program.

7. Check voltage and current requirements on print out. The values shall be:

Voltage	+15.0V	±0.5V
	-15.0V	±0.5V
Current - Positive	85.0	±5.0 ma
Negative	11.0	±1.0 ma

8. Check temperature reading and null offset.

9. If satisfied with temperature and null offset disengage switch 1 on computer switchboard.

10. Insert maximum rate desired and rate increment (degrees/second). Example: 500, 50.

11. Run test.

12. Check data printout and test summary:

    - Full Scale Rate
    - Scale Factor*
    - Bias*
    - Hysteresis, Negative Rates
    - Hysteresis, Positive Rates
    - Null Offset**

    *Determined by least squares fit.
    **Added after initial baseline test.

13. Note temperature, relative humidity, date, and barometric pressure.

14. Check percent of full scale linearity to be less than 2%.

15. Rerun program at new maximum rate until linearity error exceeds 2%.

16. For this program rate increments have been set at 50 degrees/second.

17. Load "output drift/readytime/threshold/resolution" program into the 9500A computer test set and turn on rate table controller.

18. Connect the Honeywell 1858 Visicorder to the patch panel on the Hewlett Packard 9500A test set. The remote drive on the visicorder is connected to D21 and D22 on the patch panel . Set time lines to .01 seconds and chart speed to 8 inches/second. Using a channel on the visicorder with a sensitivity of 500 millivolts per division, connect the signal line to D29 and the return line to L27 on the patch panel. The remote drive is programmed to run recorder for 250 milliseconds, turn on the sensor and measure output for 750 milliseconds.

19. Run program.

20. When bells ring, set sensitivity on recorder to 100 mv/division for 100 deg/sec. This must be done within two minutes after sounding bell.

21. When bells ring, set sensitivity to 200 mv/division for 200 degrees/second - two minute wait.

22. When bells ring, set sensitivity to 500 mv/division. This will be setting for 300, 400, and 500 degrees/second rates.

23. Data Printout:
    Output Drift
    Null Offset

24. Engage Switch 1 on computer switchboard and run program.

25. Set sensitivity of recorder to 5mv full scale. It may be required to use an external power generator to offset the null offset voltage of any sensor.

26. Set recorder drive to manual and set at .8 inches/second, chart speed with time lines at 10 second intervals.

27. Operate the rate table controller manually from zero degree/second to 1.0 degree/second in 0.1 degree/second increments. Allow each increment to run 1 second minimum.

28. Operate the rate table controller manually from 5.0 to 6.0 degrees/second in 0.1 degrees/second increment. Allow each increment to run 1 second minimum.

29. Stop program.

30. Repeat Steps 1 thru 29 for other units.

31. For 165^{o}F, connect heater wires and monitor thermistor until resistance is 6750 OHMS $\pm$200 OHMS. Soak unit for 45 mintues.

    For -30^{o}F, connect liquid nitrogen hose to top of chamber and monitor flow and dry nitrogen pressure until thermocouple wire is -30^{o}F $\pm$5^{o}F. Soak for 45 minutes.

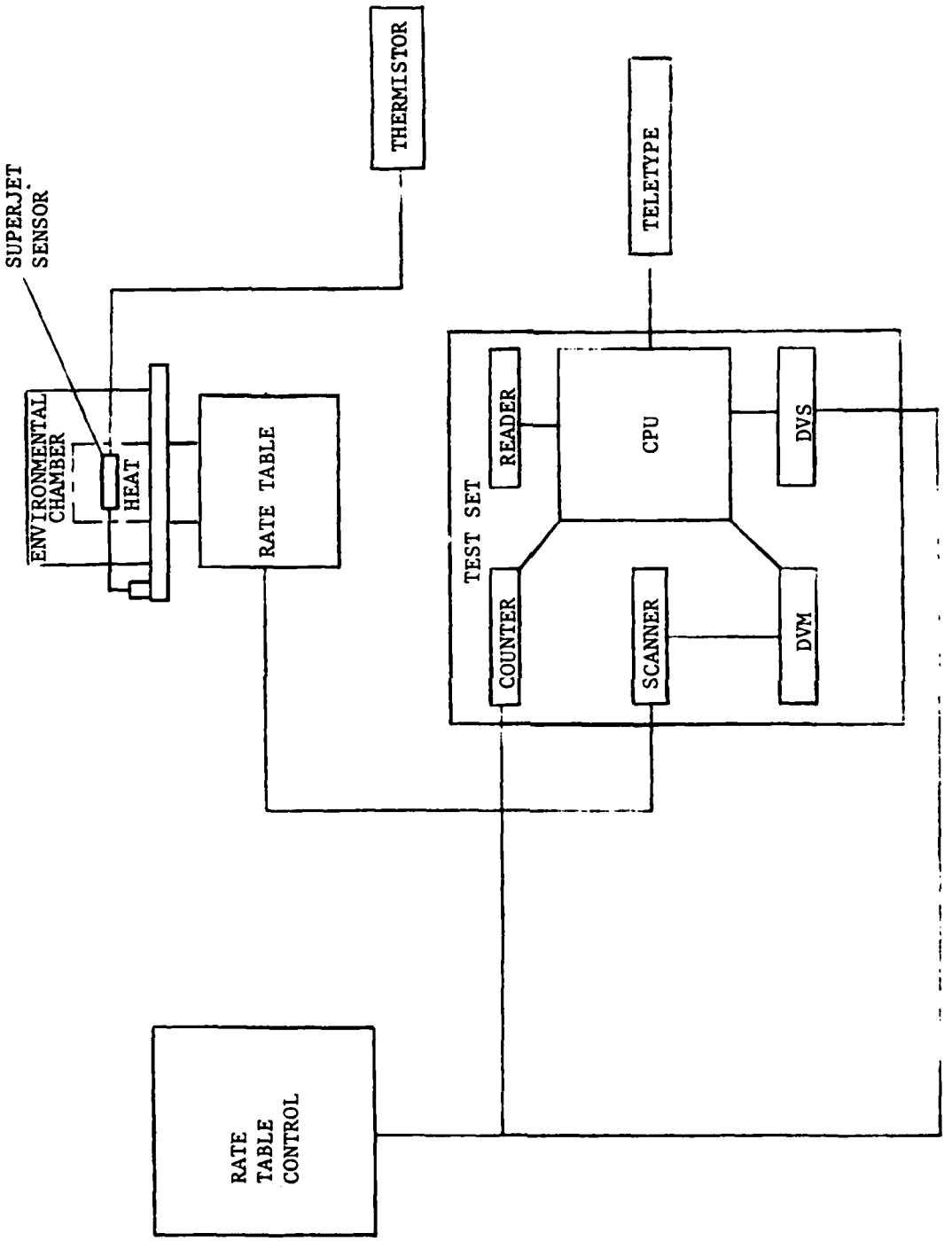


FIGURE C.3-1

HIGH TEMPERATURE TEST SCHEMATIC

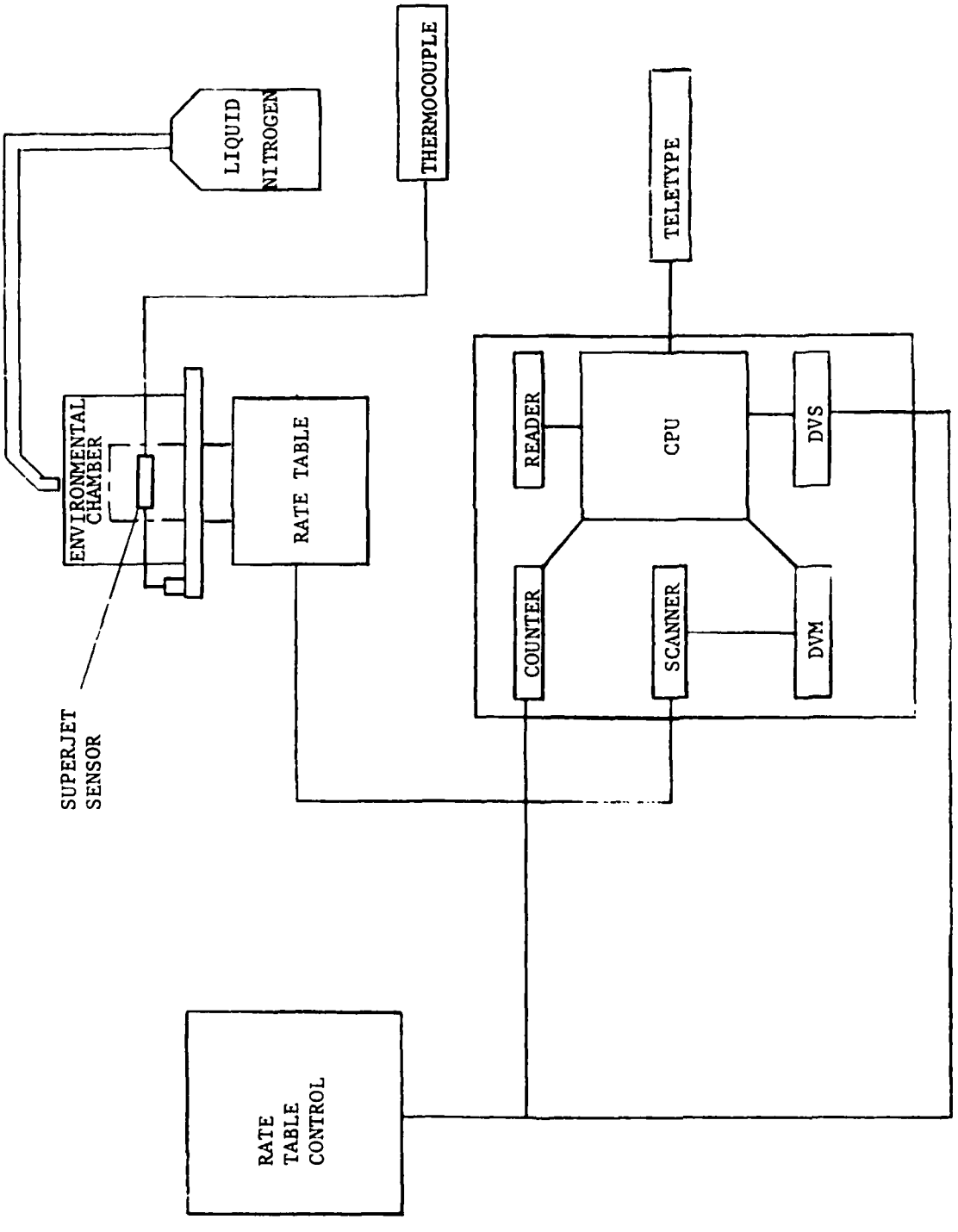


FIGURE C.3-2

LOW TEMPERATURE TEST SCHEMATIC

D. JERK SENSITIVITY

D.1 Parameters to be measured:

Output at Various Jerk Rates
Null Offset

D.2 Test Setup

The Jerk tests are to be conducted at 77°F ±10°F and less than 90% relative humidity. The following equipment is to be used:

Hewlett Packard 9500A Test Set
Genisco G1100-2 Rate Table and Controller
BWC 032580-003 Arm
BWC 032580-004 Angle
BWC 032580-005 Plate
BWC 032580-001 Test Plate
BWC 032580-002 Test Plate
8"X8"X8" Test Cube

A test schematic is shown in Figure D.2-1.

D.3 Test Procedure

The jerk test was performed by the following steps:

1. Install test plate BWC 032580-001 to top of Gensico 1100-2 rate table. Insure that "connector" stamped on plate in near connector located on rate table.

2. Install test plate BWC 032580-003 into 8"X8"X8" cube test fixture.

3. Install Superjet sensor on test plate BWC 032580-002 insuring that sensor is located on the rate table centerline.

   Mount cube test fixture as follows:

AXIS ACCELERATED	HOLE PATTERN USED ON BWC 032580-002 TEST PLATE
X	1
Y	1
Z	3 (Jet Axis Down)

   Check to see that sensor centerline is on rate table centerline.

4. Connect wires on rate table to sensor.

5. Load "jerk test" program in 9500A computer test set and turn on rate table controller.

6. Disengage Switch 1 on computer switchboard.

7. Engage Switch 14.

8. To abort test switch 15 should be engaged.

9. Run program.

10. Insert measurement rate of 250 or 500 degrees per second and direction of rotation.

11. Run test.

12. Check data printout.

13. Note temperature, relative humidity, date and barometric pressure.

14. Repeat steps 3 through 13 for each axis and unit, (should be 6 runs for 3 units since X and Y axis runs are identical).

15. Remove test plates and test cube from rate table.

16. Attach BWC 032580-003 arms to rate table.

17. Attach units to either BWC 032580-004 angle or BWC 032580-005 plate depending on which axis is accelerated (make sure that both sides are identical for maintaining proper rate table balance).

18. Connect electrical pigtails to one of the units.

19. Run program.

20. Input measurement rate of 250 or 500 degrees/second.

21. Run test.

22. Check data printout.

23. Note temperature, relative humidity, date and barometric pressure.

24. Repeat steps 17 through 23 for all configurations.

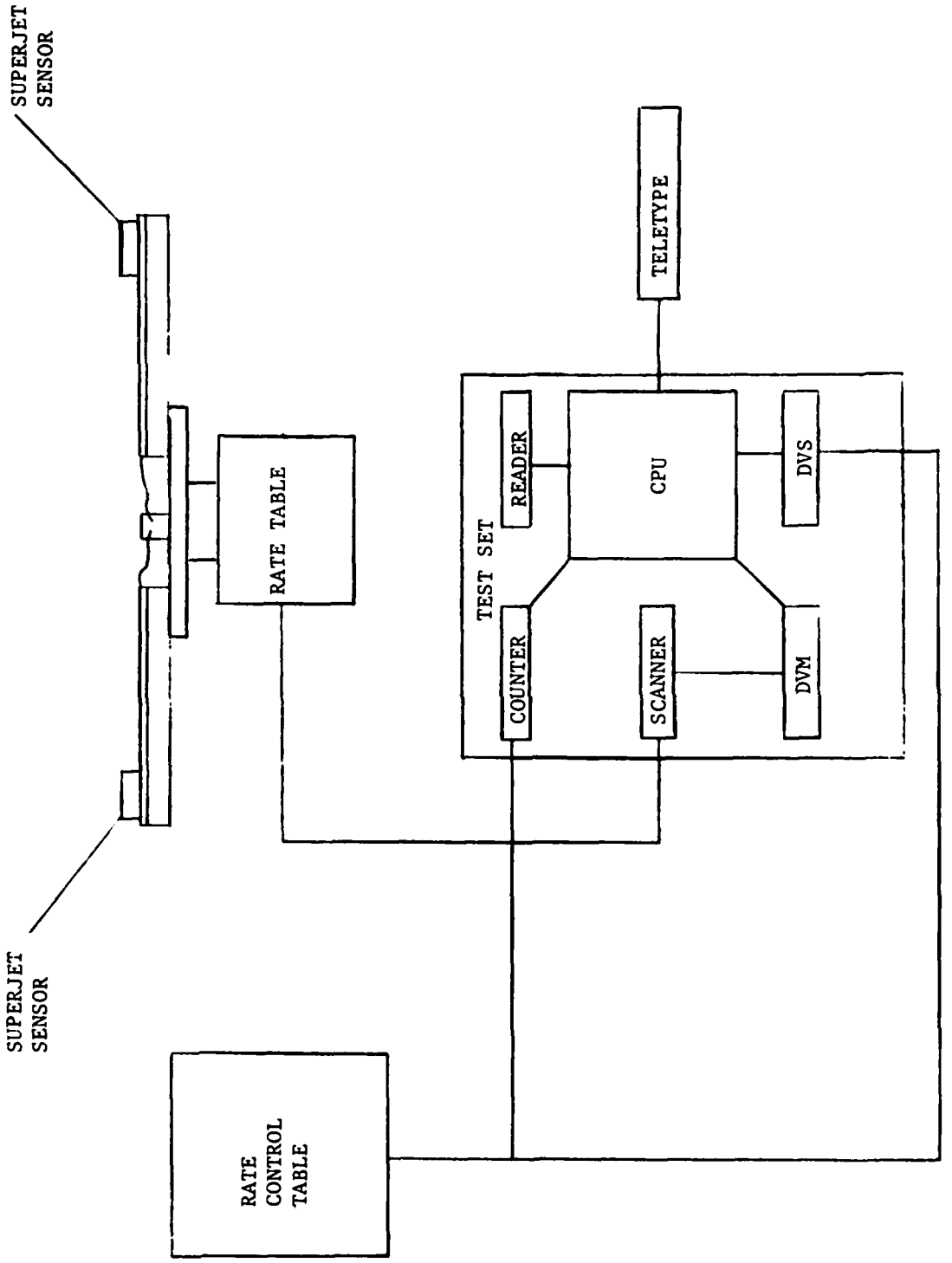


FIGURE D.2-1
JERK TEST SCHEMATIC

E. ACOUSTIC SENSITIVITY

E.1 Parameters to be measured:

Overall Decibel Level
Null Output

E.2 Test Setup

The acoustic test was conducted at 72°F and less than 90% relative humidity. The equipment used was:

Martin Marietta Acoustic Chamber
Hewlett Packard Model 5451B Acoustic Analyzer
Honeywell 1858 Visicorder
Martin Marietta Control Box
Digitec 262C Multimeter
Philbrick Researches PR-300 Power Supply

A test schematic is shown in Figure E.2-1.

A test schematic describing the monitoring of each unit is shown in Figure E.2-2.

E.3 Test Procedure

The acoustic test was performed by the following steps:

1. Install unit on beam support and position in acoustic chamber throat area.
2. Position three microphones surrounding the test article as described in MIL-STD-810C method 515.2 paragraph 3.5.2.1.
3. Connect test unit to control box.
4. Connect +15 V.D.C. and -15 V.D.C. to control box.
5. Connect white wire on test unit to (+) signal on digital multimeter (must be floating DMM, Ref 6V) and on visicorder.
6. Connect grey wire on test unit to common on DMM, and on visicorder.
7. Connect real time noise analyzer to recorder and set at 170 db full scale.
8. Turn on DMM and set sensitivity to read millivolts.
9. Turn on recorder set at 0.8 inches/second chart speed and 10 second time lines.

10. Turn on test unit by turning power switch to "warmup" on control box.

11. Apply acoustic environment of eight 10 second $\pm$8 second pulses and achieve the maximum overall db level, but do not exceed 165 db.

12. End test.

13. Repeat steps 1 through 12 for other units.

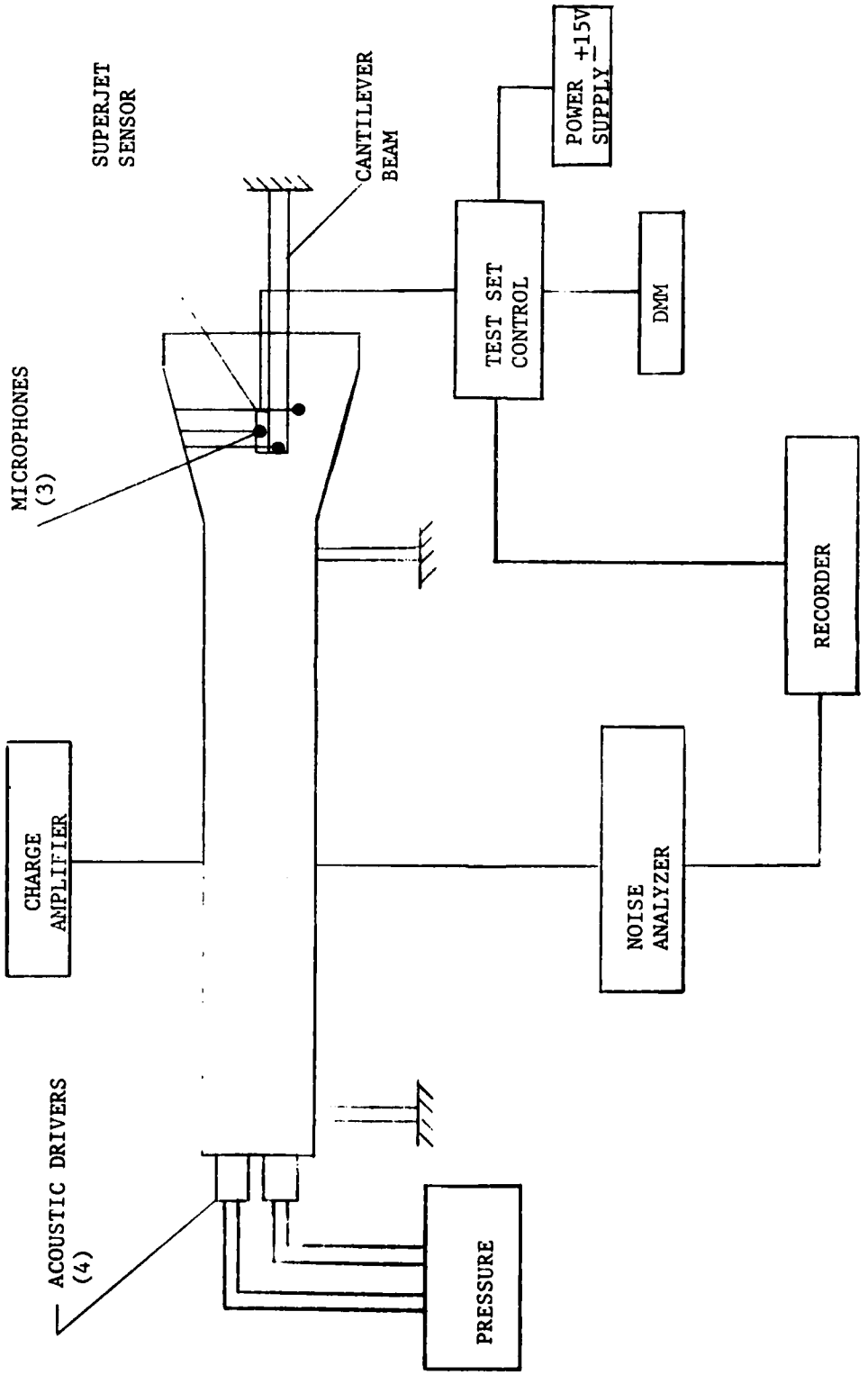


FIGURE E.2-1

ACOUSTIC TEST SCHEMATIC

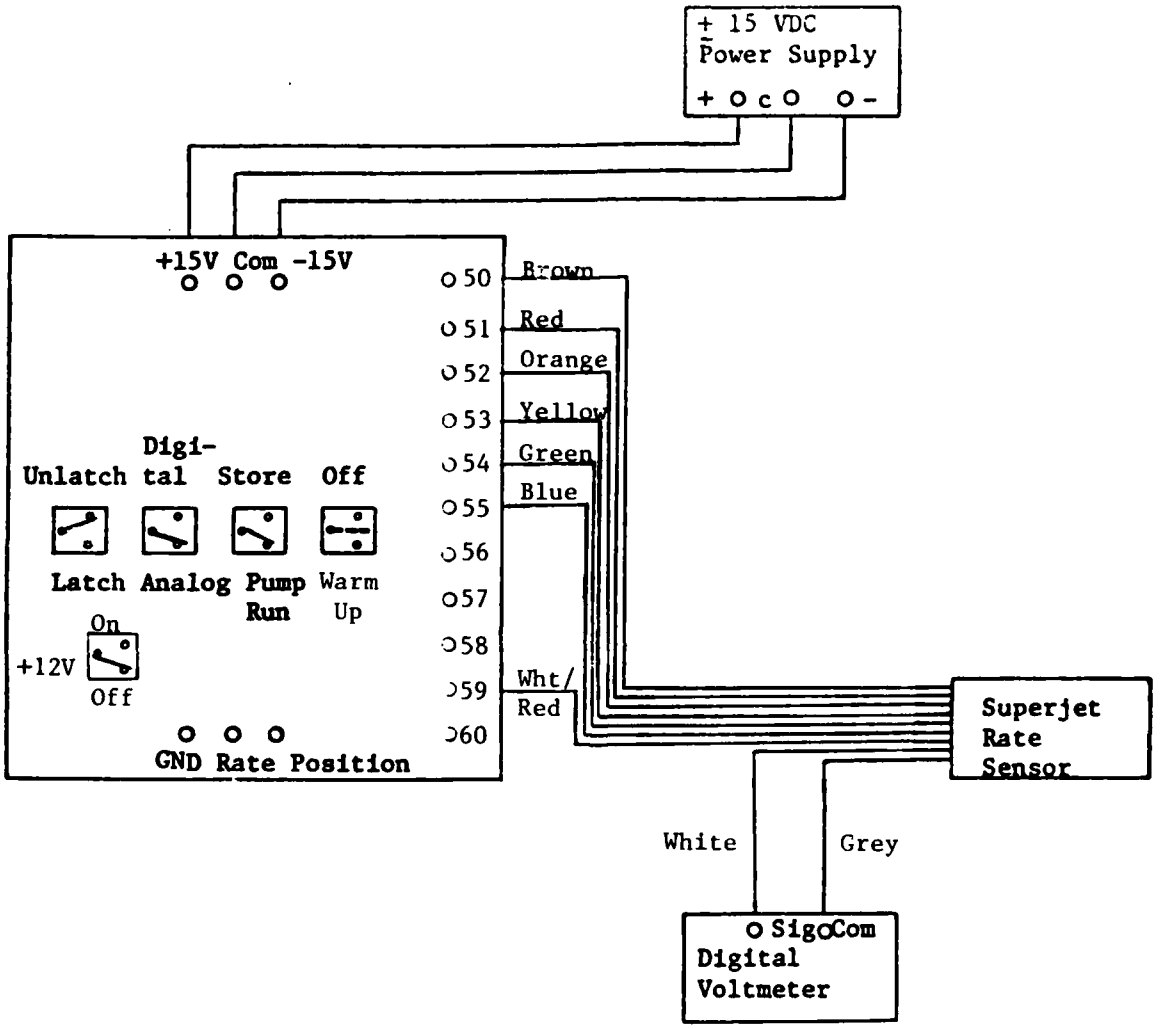


FIGURE E.2-2

TEST SET CONTROL

APPENDIX A - PART F

F. VIBRATION

F.1 Parameters to be measured:

Most Severe Resonances (3)
Null Output

F.2 Test Setup

The vibration test was conducted at 70°F and less than 90% relative humidity. The test was performed in the environmental test laboratory at Martin Marietta. The equipment used was:

C-60 Vibration Test Set
10 - 3000 Hz capability
Endevco Dynamometer Model 2702B
Accelerometer 2222B S/N FX15
(.3% sensitivity)
Honeywell 1858 Visicorder
Martin Marietta Control Box
Digitec 262C Multimeter
Philbrick Researches PR-300 Power Supply

The test setup is illustrated schematically by Figure F.2-1, and Figure E.2-2.

F.3 Test Procedure

Each test run was based on the following step-by-step procedure:

1. Install unit on test fixture mounted on test cube located on the C-60 Vibration Test Set.
2. Annotate orientation.
3. Connect control accelerometer to monitor vibration input (3.0 or 5.2g rms).
4. Mount accelerometer 2222B on Superjet sensor in a manner to monitor the output of the axis under vibration.
5. Connect control accelerometer to visicorder. Set sensitivity to 10 g/in.
6. Connect output accelerometer to visicorder to 10 g/in.
7. Connect unit to control box.
8. Connect +15.0VDC and -15.0VDC and common to control box.
9. Connect white wire on test unit to the (+) on digital multimeter (must be floating DMM, Ref. 6V).

10. Connect grey wire on test unit to common on DMM.

11. Connect white and grey wires to visicorder. Set sensitivity to 20 mv/in.

12. Connect frequency counter on C-60 test set to visicorder. Set sensitivity to 5 v/in.

13. Set chart speed to 0.1 in/sec and timelines to 10 second intervals.

14. Start visicorder.

15. Turn on unit at control box (power switch to "warmup").

16. Apply resonance search at 3g rms from 10 to 3000 Hz over a period of 3.5 minutes.

17. Stop visicorder.

18. Select the three most severe resonances and annotate.

19. Start visicorder.

20. Dwell unit for 10 minutes at each selected resonance.

21. Stop visicorder.

22. Turn off unit.

23. Repeat test for each orientation and other units.

24. Repeat baseline test per Part A.

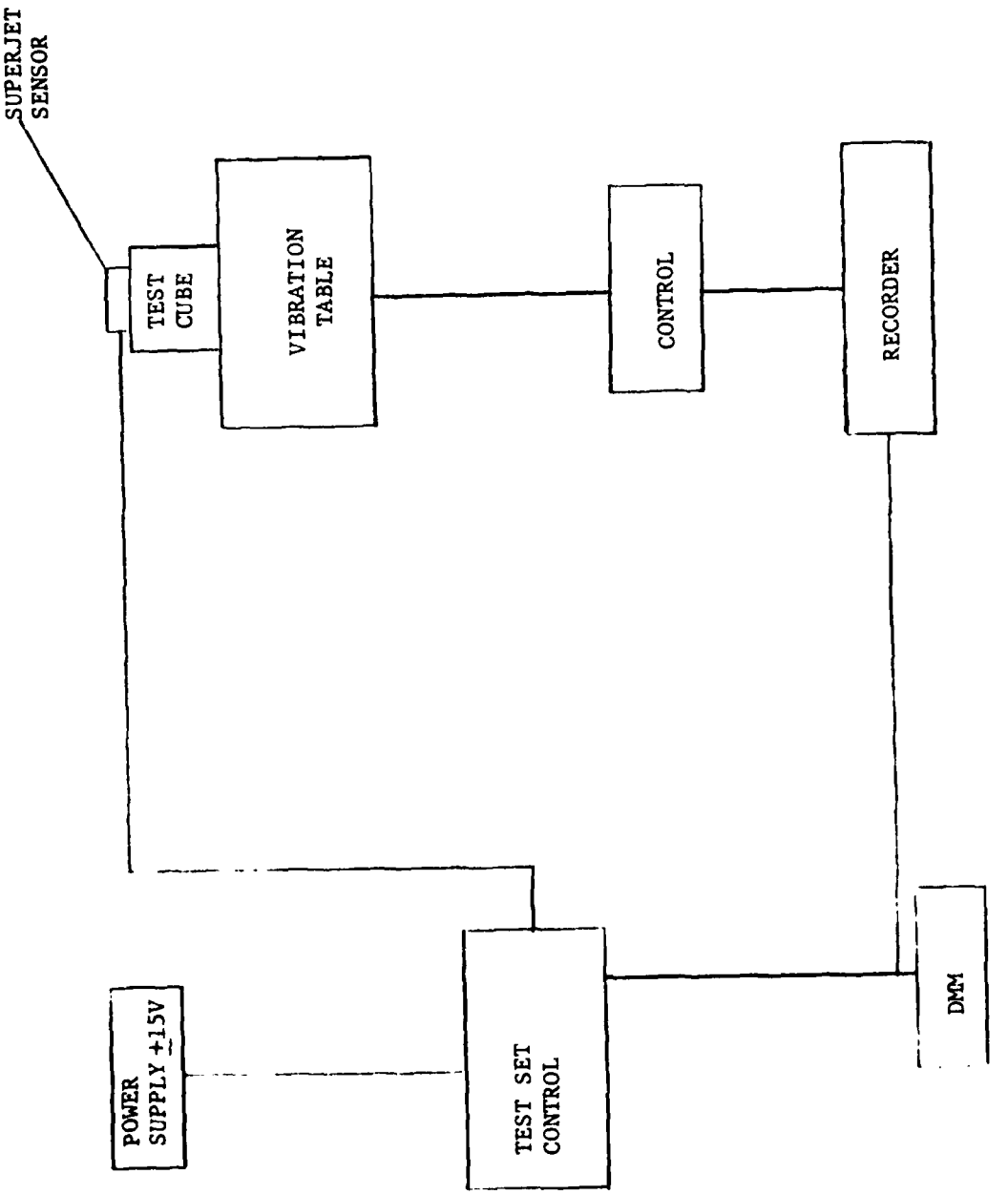

SUPERJET SENSOR
TEST CUBE
VIBRATION TABLE
CONTROL
RECORDER
POWER SUPPLY ±15V
TEST SET CONTROL
DMM

FIGURE F.2-1

APPENDIX B

TEST PLAN
for
Performance Verification Tests
on the
SUPERJET Angular Rate Sensor

Contract No. DAAK40-79-D-0017

November, 1979

Prepared by

Jerome C. Salmons

Dept. 5463

Martin Marietta Corporation
Orlando, Florida

FOREWORD

This document is prepared to fulfill the requirements of paragraphs 3.2.1.5 and 3.2.1.6 of Statement of Work 60134-12 dated 7 August 1979 which describes the effort authorized under Operations Directive No. 3-0017-00-375-15. This O. D., issued 19 October 1979, implements contract number DAAK40-79-D-0017 with the Naval Air Development Center Aircraft and Crew Systems Technology Directorate, Warminster, Pa. 18974. Under the terms of the referenced contract Martin Marietta is to evaluate the Hamilton-Standard SUPERJET angular rate sensor for possible application in the Maximum Performance Escape System (MPES) Program being conducted by the Naval Air Development Center (NADC). A major portion of the evaluation effort will involve performance tests under various environmental conditions. This document describes the test program to be conducted and gives a time schedule for the accomplishment of major milestones.

CONTENTS

TABLES

ILLUSTRATIONS

SUMMARY

This test plan document describes the scope of effort to be expended in evaluating the performance of Hamilton-Standard's SUPERJET roll rate sensor (RRS) for application to a Navy Air Development Center (NADC) Program. The tests to be conducted are described, the number of test units to be employed is given and the test levels for each test are specified. Test schedules and data formats for each test are presented. Measurements to be made are listed and test apparatus to be used is specified.

1. INTRODUCTION

1.1 Purpose

The SUPERJET is an angular rate sensor produced by the Hamilton Standard Division of United Technologies, Inc. One version of this device containing associated electronics for shaping and correcting the output and providing switching and null bias functions is being developed for use on the Copperhead projectile as a roll rate sensor.

In a previous study conducted by Martin Marietta Corp., Orlando, Florida, the potential application of the SUPERJET to air crew ejection systems was recognized. The final report of this study effort (OR 15646) recommended further evaluation of the SUPERJET to better define its potential for such application. The purpose of this test plan is to describe the test activities involved in the evaluation effort and to establish a time schedule for performing the test effort.

1.2 Test Objectives

The major objectives of this test program are to demonstrate feasibility of less than 2 deg/s bias error with 0.1s ready time and linearity of 1 percent over the rate range of $\pm$ 500 deg/s at any temperature between -65° F and + 165° F.

Secondary objectives will be to determine the effects on sensor output of high and low temperature, linear acceleration, rate of change of acceleration, vibration and acoustic environments.

Where it can be determined that tests equivalent to those specified herein have been conducted on other programs, the data from such tests may be presented in lieu of duplicating those tests.

2. APPLICABLE DOCUMENTS

2.1 Authorizing Documents

1.	Contract	DAAK40-79-D-0017
2.	Statement of Work, NADC No.	60134-12
3.	Operations Directive, Martin Marietta No.	3-0017-00-375-15

2.2 References

1. Martin Marietta Reports

Fluidic Gyro Development, August, 1979	OR15,646

2. Military Standards

Environmental Test Methods	MIL-STD-810C Change 4

3. Specifications, Martin Marietta

Roll Rate Sensor	*SPC 10200000-004*

3. TEST APPROACH

3.1 Test Facilities

The test program described herein is to be conducted by various laboratories of Martin Marietta Corp., Orlando, Florida. Room temperature performance tests will be conducted on a rate table in the Fluidics Lab or Precision Inertial Laboratory. The Dynamics Lab and the Environmental Test Lab will provide equipment for generating vibration and acoustic environments and shall provide all necessary measurement and recording equipment for these tests. Temperature chambers mounted on a rate table will be used for creating the high and low temperature environments during rate tests. At this time it is proposed to use thermostatically controlled electric heaters for creating the high temperature environment. The low temperature environment will be created by flowing gaseous nitrogen from a liquid N_2 supply through an insulated chamber on the rate table.

3.2 Test Equipment

Test equipment necessary for conducting this test program is given in Table 1.

3.3 Test Articles

The roll rate sensors to be tested are identified as Hamilton Standard P/N 9304100099. Serial number 0100196 and 0100142 are presently available from a previous test program. Additional units of the same part number will be obtained by transfer or consignment from the Copperhead program, or purchased from Hamilton Standard should it prove impractical to use Copperhead units.

AD-A091 089 MARTIN MARIETTA AEROSPACE ORLANDO FL F/G 1/3
PERFORMANCE VERIFICATION OF THE 'SUPERJET' LAMINAR ANGULAR RATE--ETC(U)
MAY 80 B W CURRY DAAK40-79-D-0017
UNCLASSIFIED OR-16127 NADC-80081-60 NL

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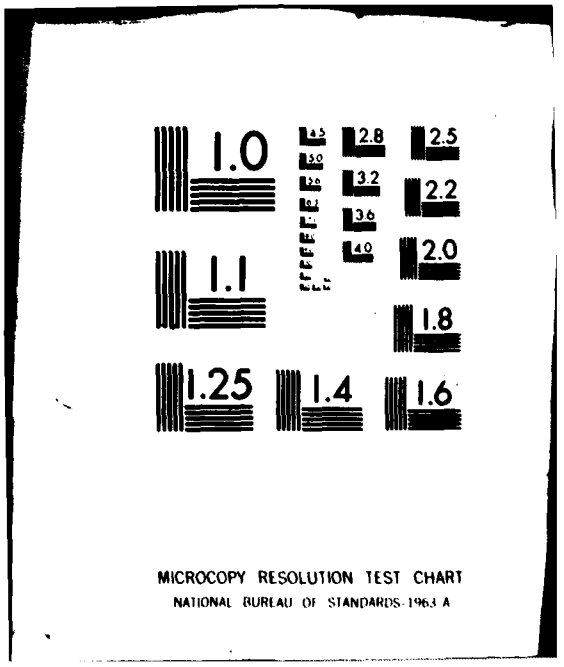
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963 A

TABLE 1

Test Equipment[1]

Model No/ Part No.	Description/Manufacturer	Accuracy (%)
	Power Supply +5v	±1.00
	Power Supply +11.5v	±1.00
	Power Supply +15.0v	±1.00
	Power Supply -15.0v	±1.00
HP3440 or HP3465B	Digital voltmeter-Hewlett Packard High Impedence 0-100 mv range	0.25
	RRS Test Set	----
	Acoustic chamber-Martin Marietta	----
Model	MB Shaker	
Model G-1100	Rate table-Genisco	----
	Rate table controller-test set-Hewlett Packard	----
	Temperature control chamber Martin	----
Model 1054	Precision Centrifuge-Martin-Genisco	----

[1] Similar equipment having adequate performance characteristics for the usage intended may be substituted. Test data sheets shall note the actual equipment used.

3.4 Test Descriptions

3.4.1 Base Line Performance Tests

These tests shall be performed at room ambient conditions of 77°F ± 10°F and less than 90% relative humidity. The unit under test (UUT) shall be at a stable temperature prior to test. Unless otherwise implied or specified, the following tests will be made while the sensor is motionless with its base in contact with a horizontal support surface;

1. Input voltage and current requirements will be measured at the power supplies.
2. Output drift - the sensor output change with time shall be determined for constant rate inputs.
3. Output scale factor - (volts/deg/sec)
4. Full scale range for 2% linearity
5. Threshold
6. Resolution
7. Hysteresis

3.4.2 Ready Time

A test for "ready time" shall be made by recording the output characteristic of the sensor as the unit is activated. The recording shall be measured to determine the steady state output level. "Ready time" is the time required for the unit to respond to the activation signal and develop and output equal to 95 % of the steady state level.

3.4.3 Acceleration Sensitivity Tests

3.4.3.1 Constant Acceleration

The unit will be oriented on a centrifuge and subjected to constant accelerations in each direction along each of the three mutually perpendicular axes (reference Figure 1). Various levels of acceleration shall be applied up to a maximum of 30g. The sensitivity of the sensor output to the applied acceleration shall be determined.

3.4.3.2 Constant Jerk

The centrifuge will be programmed to produce linearly varying accelerations by linearly changing the rate of rotation. The rate of change of acceleration shall be varied in increments from zero to 10g/sec. The sensitivity of the sensor output to the applied rate of change of acceleration (jerk) shall be determined. The acceleration vectors shall be oriented in each direction along the three test axes shown in Figure 1.

3.4.4 Vibration Tests

The sensitivity of the unit to vibration environments will be evaluated by tests conducted in accordance with MIL -STD-810C procedures. Vibration will be applied along the three axes defined in Figure 1.

A resonance search will be performed at a maximum level of 3g from 10 to 5000 Hz in each axis. The three most severe resonances in each axis will be selected. The unit will then be vibrated at each of the three selected frequencies in each axis for 10 minutes. The test level shall be 5.2g.

Null output shall be monitored during vibration.

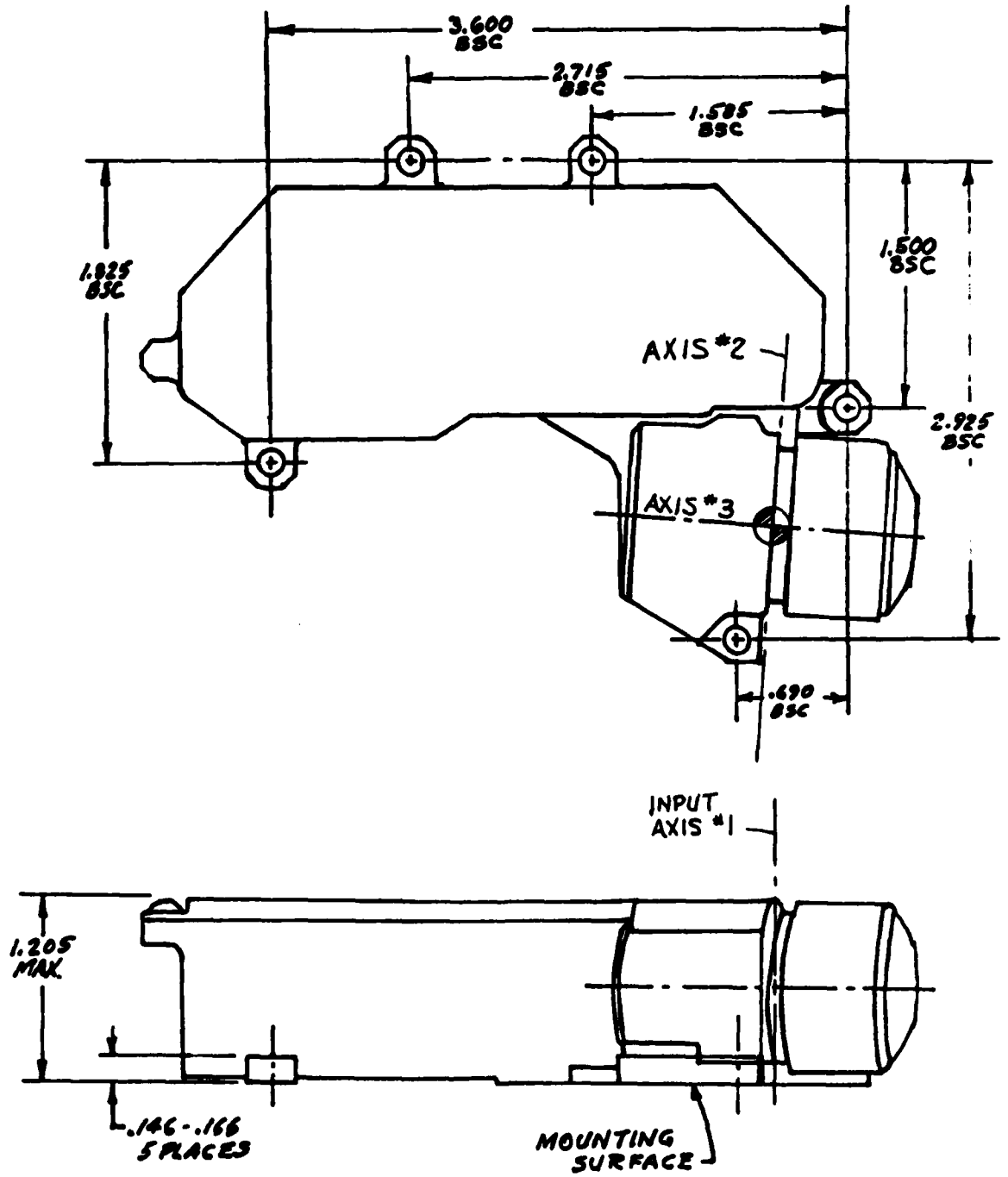


Figure 1 RRS Mounting Dimensions and Orientation

3.4.5 Acoustic Sensitivity

The sensitivity of the RRS to high level acoustic environment will be evaluated by tests conducted in general conformity to MIL-STD-810C. The RRS will be suspended in an acoustic chamber on elastic cords having a natural frequency less than 25 Hz. Procedure 1 of MIL-STD-810C will be used as a guide. A category B test will be conducted (150 db for 30 minutes) to evaluate the effects of longer term acoustic environment on the RRS output. Measurements of the RRS output will be made at intervals no greater than 5 minutes during this test. A category D test will be conducted for limited time periods. A minimum sound pressure level of 165 db will be applied in "pulses" of approximately 1 second duration. The sound pressure level will be brought up to the maximum level in the minimum time period consistent with laboratory operating procedures and equipment capabilities. Following the sound "pulse" the pressure level will be allowed to decay in accordance with inherent equipment characteristics. This short duration acoustic pulse will be applied to the energized RRS a minimum of 8 times. The output will be continously recorded. Acoustic effects on the RRS output will be determined by comparing the recorded null output during and following the acoustic pulse to the output recorded just prior to application of the acoustic environment. In addition, results of post-environment performance tests will be compared to pre-environment performance baseline tests.

3.4.6 Temperature Sensitivity Tests

The baseline performance tests will be conducted at -65°F ± 5°F and at +165°F ± 5°F. The temperature chamber shall be stabilized at the test temperature preceeding the testing. Data from these tests shall be compared to room temperature test data to determine temperature sensitivity.

4. TEST IMPLEMENTATION

4.1 Test Procedures

The major tests necessary in the conduct of this test program are as follows:

1. Baseline performance tests.
2. High temperature test.
3. Low temperature test.
4. Acceleration test.
5. Rate of acceleration (jerk) test.
6. Vibration test.
7. Acoustic sensitivity test.

A detailed test procedure shall be written giving the steps to follow in conducting the above tests. The procedure will define the order of testing, when the RRS is to be operated, how and when the environmental exposure is to be applied, the parameters to be measured and recorded, and the frequency or time of measurement. Baseline performance will be established prior to and following environmental exposures.

4.2 Failure Documentation

In case of equipment failure appropriate entries as to schedule impact and corrective action shall be made in the test logs by the test program engineer.

In case of failure of the Unit Under Test , a full description of the test conditions and nature of the failure will be given in the test report. Failure analysis, failure testing and failure reports are beyond the scope of this program.

4.3 Data Requirements

4.3.1. Photographic Documentation

Photographs will be employed as necessary to supplement drawings, sketches, and descriptive material in the test report, such that test set-ups may be reconstructed or duplicated. Orientation of the test specimen during environmental exposures is of particular interest and must be fully documented.

4.3.2. Data Sheets

Data sheets similar to the example shown in Appendix A will be prepared for use with each test procedure and shall contain as a minimum the following entries in addition to sections for recording observed performance data.

Name of Test

Place of Test

Part number & serial number of test article

Pertinent test equipment model/serial numbers

Date

Test conditions @ Start Finish

Time of day

Temperature

Baro. press

Humidity

Test Engineer(s) attesting signature

4.3.3 Oscillograph Records

Oscillograph records shall be annotated to indicate trace identification, scale factors, and time of events and shall be identified with the entries listed in paragraph 4.3.2.

4.4 Schedule and Milestones

A schedule for conducting the tests described herein is shown in Figure 2. It is planned that all testing shall be completed by 1 April 1980. Test data reduction, analysis, evaluation and presentation and preparation of descriptive test results will be completed by 1 May 1980. Test results will be made available to NADC on or before 15 May 1980. The formal test report will be a part of the program final report.

5. DEFINITIONS

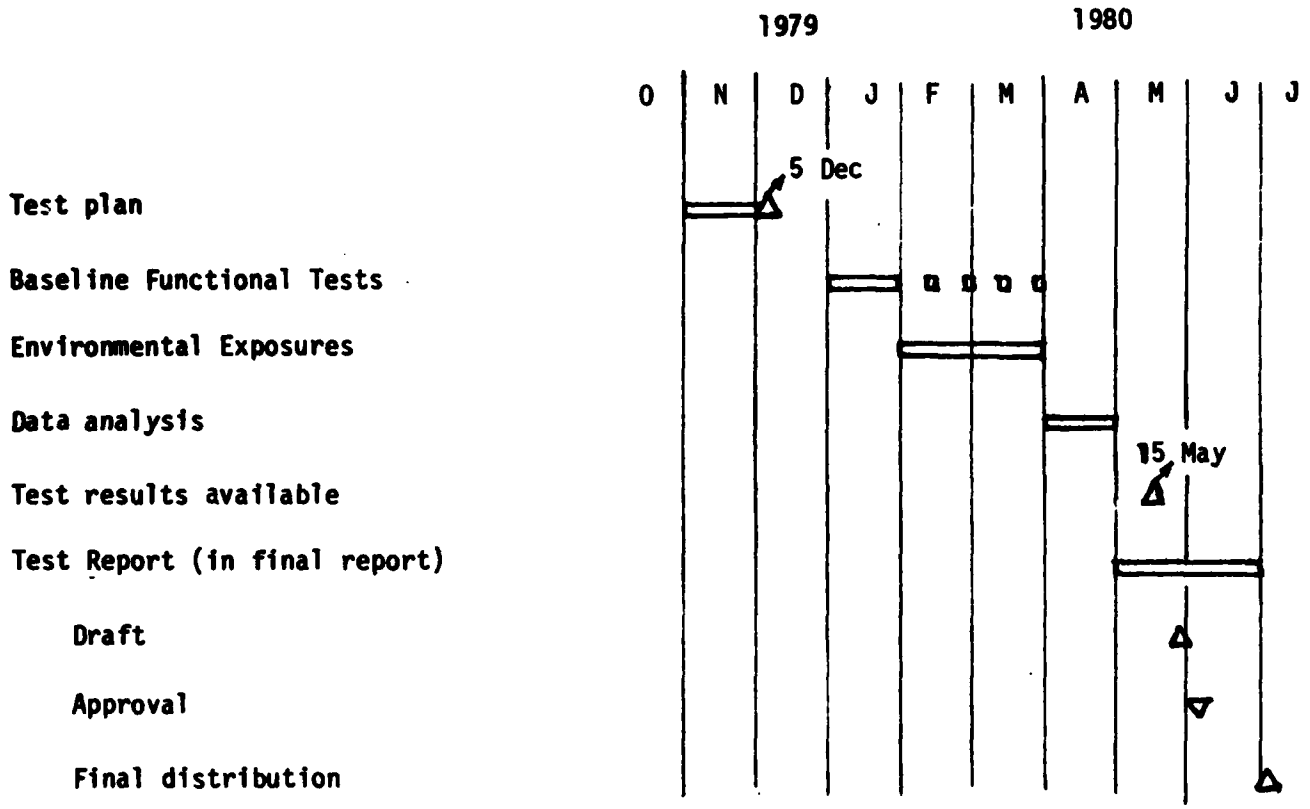
Scale Factor - slope of best fitting straight line to test data.

Linearity - the deviation of the output data from the best straight line fit to the data and through the zero rate point.

Null Bias - output of rate sensor at zero rate input. Also termed "offset".

Hysteresis - the difference in output at any rate when approached in opposite directions.

Figure 2 ROLL RATE SENSOR TEST SCHEDULE



APPENDIX A

TYPICAL DATA SHEET

Test:_____
Run No.:_____

		Start	Finish
Date: _____	Time:	_____	_____
Laboratory: _____	Temp:	_____	_____
Test Machine: _____	Baro. Press:	_____	_____
	Relative Humidity:	_____	_____

Test Article I. D.
Name: _____
Part No.: _____
Model No.: _____
Serial No.: _____

Input: Voltage _____
Current _____
Power _____

NOTES:

DATA		DATA ANALYSIS RESULTS
Input	Output	

This test conducted in accordance with paragraph ___ of TPL _____ and paragraph _____ of TPR _____ except as noted.

Test Engineer:
Signature_____

Scale Factor _____
Null Bias _____
Hysteresis _____
Threshold _____
Resolution _____

APPENDIX C

LEAST SQUARES FIT ALGORITHM

Scale factor, bias and linearity:

$$Z = B + Ax$$
$$B = (Q - (A \cdot S)/H9$$
$$A = ((H9 \cdot P) - (S \cdot Q))/((H9 \cdot T) - (S \cdot S))$$
$$H9 = (4 \cdot (R1/R2))/2$$

Where:

A = Slope of Least Squares Fit Straight Line (volts/degrees/second)
B = Bias (Y - Intercept of Least Squares Fit Line (volts))
H9 = Number of Data Points
P = Sum of Inputs Times Outputs (volts/degrees/second)
Q = Sum of the Outputs (volts)
R_1 = Maximum Rate (degrees/second)
R_2 = Rate Increment (degrees/second)
S = Sum of the Inputs (degrees/second)
T = Sum of the Inputs Squared $(\text{degrees/second})^2$
X = Input (degrees/second)
Z = Least Squares Fit Straight Line (volts)

Hysteresis: Maximum

$$M = Y_1 - Y_2$$

Where:

M = Hysteresis (volts)
Y_1 = Output Recorded Approaching Maxmimum Rate
Y_2 = Output Recorded Approaching Zero Rate

OUTPUT DRIFT ALGORITHM

$$D = \frac{SF_H - SF_L}{SF_{NOM}} \times \frac{60}{t} \times 100$$

Where: SF_H = Highest scale factor at rate
SF_L = Lowest scale factor at rate
SF_{NOM} = Nominal baseline scale factor
t = Time in seconds between high and low scale factors